APPENDIX G - WAIMANALO GULCH SANITARY
LANDFILL EXPANSION REVISED DRAFT SUPPLEMENTAL EIS

ALTERNATIVES ANALYSIS FOR DISPOSAL OF MUNICIPAL REFUSE

CITY AND COUNTY OF HONOLULU, OAHU, HAWAII

March 2001

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City and County of Honolulu
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1-18263-2E

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SECTION 1
INTRODUCTION

1.1 PURPOSE AND OBJECTIVES

This study examines the potential for selection of a viable alternative to expansion of the Waimanalo Gulch Sanitary Landfill site for the City and County of Honolulu. Alternative waste disposal technologies and locations for alternative sanitary landfill sites are reviewed in relation to capacity requirements and feasibility considerations.

1.2 REPORT ORGANIZATION

This study is organized as follows:

Section 1 - Introduction
This section describes the purpose and objectives of this study. The organization of this report is also described.

Section 2 - Waste Stream Composition Overview
This section provides an overview of the composition of Oahu's waste stream. Primary features of Oahu's municipal solid waste (MSW) stream and handling methods are described. Estimated volume and efforts at waste diversion are also provided.

Section 3 - Alternative Technologies for Waste Disposal
This section provides an overview and description of potential new technologies for the diversion of waste currently sent to the Waimanalo Gulch Sanitary Landfill. Analysis of waste processing capabilities are provided along with a review of reliability and feasibility concerns.

Section 4 - Alternative Oahu Locations for Sanitary Landfills
This section investigates the availability of sanitary landfill sites throughout the island. Site selection criteria and feasibility concerns are described.

Section 5 - Analysis of Alternative Oahu Locations for Sanitary Landfill Sites
This section provides analysis of landfill sites identified in Section 4.

1.3 SOURCE DATA

Information contained in this analysis is from the City and County of Honolulu, Department of Environmental Services (ENV), and from research performed for ENV to investigate waste collection and diversion programs on Oahu. In particular, information from the following studies are used to establish the existing composition of solid waste on Oahu, and the potential for use of alternative technologies to reduce or eliminate continued dependence on sanitary landfills:

Waste Composition Study, Oahu Municipal Refuse Disposal Alternatives Study, May 1999

New Systems Research for Refuse Disposal, Oahu Municipal Refuse Disposal Alternatives Study, April 2000; and Appendix-Vendor and Technology Information, April 2000

SECTION 2
WASTE STREAM COMPOSITION

2.1 INTRODUCTION

This section describes the composition of Oahu's solid waste. The purpose is to provide the basis for understanding the overall volume and composition of waste generated, the volume that is reused or recycled, and the volume that will ultimately require either disposal treatment at H-POWER, the City's waste to energy facility, or disposal at one of two landfills on Oahu. Information in this section will be used in the sections that follow to describe requirements necessary to adequately and effectively provide for the handling of Oahu's solid waste stream.

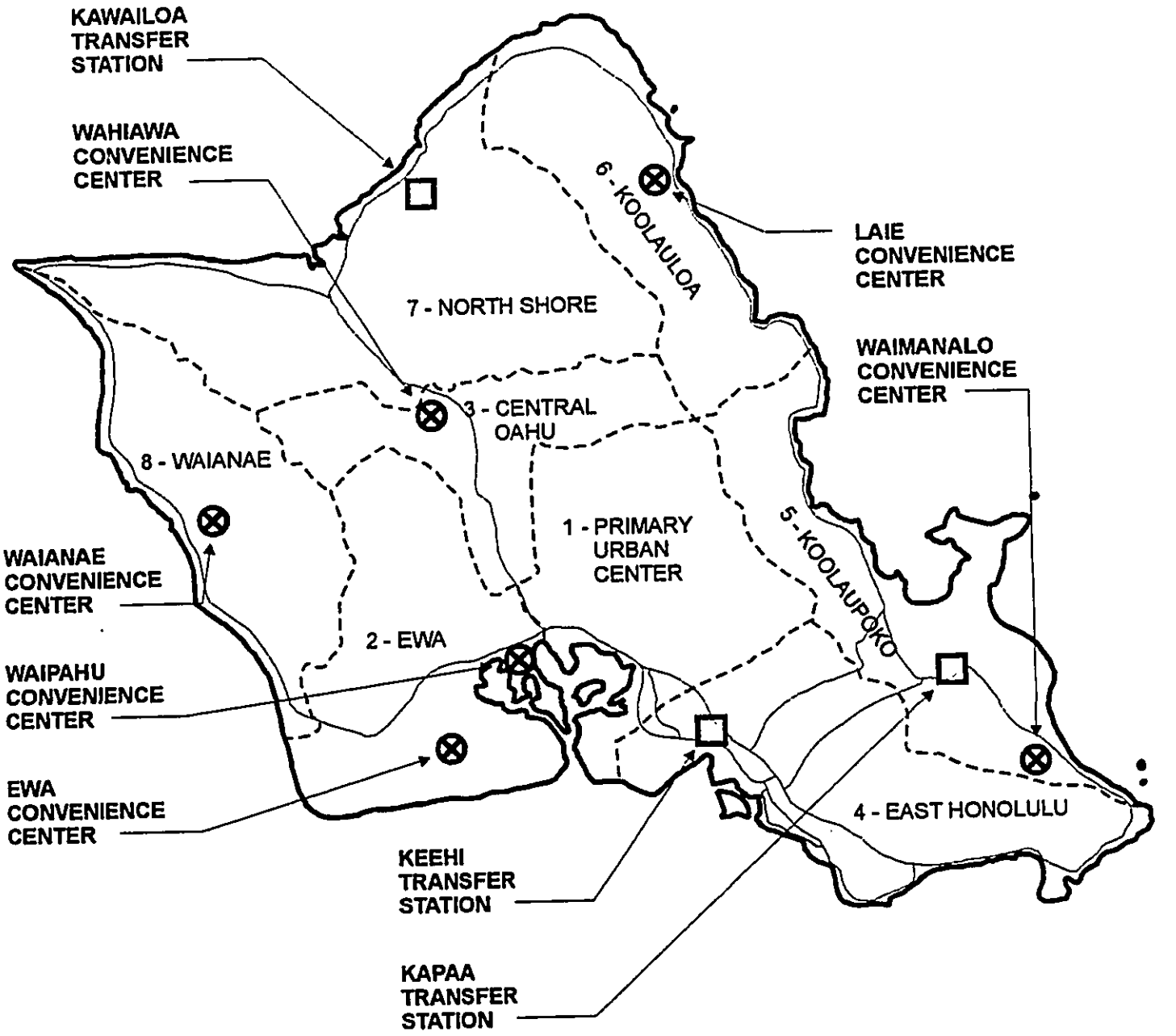
2.2 SOLID WASTE STREAM MANAGEMENT

There are three primary components involved in the management of solid waste: Collection, Diversion, and Disposal.

2.2.1 COLLECTION

The City & County of Honolulu is divided into seven collection districts (the Honolulu District is informally divided into East Honolulu and West Honolulu). These districts are: Honolulu (East and West Honolulu); Ewa; Koolaupoko; Koolauloa; Wahiawa; Waialua; and Waianae (**Figure 2-1**).

Waste from the districts is sent either to one of three transfer stations or directly to the disposal site, depending on distance from the route to the disposal point. The three transfer stations are located at Keehi, Kapaa, and Kawailoa, and are owned and operated by the City.



LEGEND

- Collection District
- Transfer Station
- Convenience Center

FIGURE 2-1
Location of Collection Districts, Waste Transfer Stations and Convenience Centers

0 2 4 6 8 10 12 MILES

Alternatives Analysis for Disposal of Municipal Solid Waste (MSW)
Dept. Of Environmental Services (ENV) • C & C Honolulu
Waste Management of Hawaii, Inc.

R.M. TOWILL CORPORATION

* Source: C & C Honolulu, ENV 2000

Residential waste from single-family dwellings is collected by the Refuse Division, Department of Environmental Services, City and County of Honolulu. The Refuse Division also collects multi-family units, and small business commercial waste. Private haulers collect most of the waste from apartment buildings and commercial facilities. The City also offers curbside collection of bulky items.

Both automated and manual trucks are used for residential waste collection. In districts with automated collection services, green waste is collected separately twice per month. All automated service areas have additional on-call green waste collection services for excess material. In areas with manual collection, green waste is collected with the rubbish. Residential waste is commingled twice per week.

The City also operates a system of six convenience centers where residents can drop off their waste. Depending on the waste type, waste from convenience centers is recycled, combusted, or disposed of in a landfill. Green waste is taken to local composters for recycling. The Convenience Centers are open from 7:00 am to 6:00 pm, throughout most of the year. These centers are at the following locations (**Figure 2-1**):

- Waimanalo Refuse Convenience Center - located on Hihimanu Street near the Waimanalo Wastewater Treatment Plant.
- Ewa Refuse Convenience Center - located on Geiger Road next to the Honouliuli Wastewater Treatment Plant.
- Waipahu Refuse Convenience Center - located on Waipahu Depot Road south of Farrington Highway.
- Laie Refuse Convenience Center - located north of Laie, on Kamehameha Highway next to the City Refuse Division Laie Collection Base Yard.
- Waianae Refuse Convenience Center - located off of Plantation Road and Hoopuhi Road north of the Waianae Intermediate School.
- Wahiawa Refuse Convenience Center - located on Wilikina Drive near the intersection with Kamananui Road.

2.2.2 DIVERSION

Waste diversion involves recovery and recycling efforts that reduce the amount of waste requiring disposal. Existing waste diversion programs in the City and County of Honolulu, include the following:

- A community recycling drop-off system currently located at various schools around the island. Materials collected include cardboard, paper, plastic, bottles, aluminum cans, and glass bottles. The drop-off system is being expanded to include additional schools and some commercial facilities, such as grocery stores and supermarkets.
- Green waste processing is done at two locations, both private operations. The private operations produce both mulch and compost. The finished product is marketed in retail stores and in wholesale bulk.
- A statewide advance disposal fee for glass provides an incentive for recycling. A fee of 1.5 cents is collected for each glass container entering the state. The processor is paid six cents per pound for the recycled glass.
- The Partnership for the Environment is a City-supported organization comprised of representatives from companies that have extensive commercial recycling activities. The Partnership acts as an information resource for expanding commercial recycling on Oahu.
- The City requires recycling of glass containers from bars and restaurants. It also requires office buildings greater than 20,000 square feet in size to recycle office paper, newspaper, and cardboard.
- Restaurants and other facilities that generate food waste are required to recycle that material.
- The City has a program to recycle materials from its offices.
- While not City-sponsored, there are commercial programs to recycle construction and demolition waste, tires, and appliances.

In addition to the above the City has initiated the In-Vessel Bioconversion Project which is intended to provide for the processing of sewage sludge and green waste into compost. Dewatered sewage sludge is currently sent to the Waimanalo Gulch Sanitary Landfill for disposal. The proposed in-vessel project will reuse this waste product in various applications including landscaping by both the public and private sector. If successful, the project will further reduce another waste stream requiring disposal. The City is soliciting bid proposals from interested parties. Because of the scale and scope of the project, the planned schedule for startup is by 2003.

2.2.3 DISPOSAL

Disposal is the last component of the waste management system. The City and County operates two disposal facilities, and a third is privately operated. The City facilities are the Waimanalo Gulch Sanitary Landfill and H-POWER. PVT Land Company operates the private construction and demolition landfill facility.

H-POWER is a waste-to-energy plant that processes about 2,000 tons of waste per day (approximately 620,000 tons of waste in 1998) and generates electricity. Ferrous metals are reclaimed prior to incineration of waste, and non-ferrous metals are reclaimed from the ash following incineration.

The Waimanalo Gulch Sanitary Landfill accepts waste, including the ash from H-POWER. Municipal Solid Waste (MSW) comes mostly from private waste haulers and commercial self-haulers. The PVT Landfill accepts only inert construction and demolition materials.

2.3 MUNICIPAL SOLID WASTE COMPOSITION

Municipal Solid Waste (MSW) is comprised of waste from residential and commercial generators and enters the system in three primary categories: residential, commercial, and convenient center. The residential waste substream includes waste disposed by households.

Commercial waste is waste collected generally by non-Refuse Division vehicles, including private commercial waste haulers, other City & County departments, and the public (including individual businesses and residential self-haulers). It primarily includes waste disposed at businesses, institutions, multi-family residences and condominiums.

The Convenience Center substream is comprised of waste destined for either combustion at the City's garbage-to-energy facility, H-POWER, or the Waimanalo Gulch Sanitary Landfill by residents, at the six Convenience Center drop-off stations operated by the City.

2.3.1 INTRODUCTION

An analysis of waste composition was taken from each of the waste disposal substreams to statistically ascertain the quantities of waste disposed. The results are provided in the following sections[1]:

2.3.2 Overall Waste Composition
2.3.3 Residential Waste Composition
2.3.4 Residential Waste Composition by District
2.3.5 Commercial Waste Composition
2.3.6 Convenience Center Generated Waste

Sampling of the different waste streams was carried out between March 1998 and February 1999. Load and tonnage data obtained from the City was used to establish sampling frequencies for each type of waste at each facility. As each designated sample load arrived, the field supervisor noted the hauler name, vehicle number and vehicle type. At the end of the shift, the field supervisor also recorded the net weight of each sample load.

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[1]Waste Composition Study, Oahu Municipal Refuse Disposal Alternatives Study, May 1999, City and County of Honolulu, Dept. of Environmental Services, by R.M. Towill Corporation.

The entire truckload of waste was dumped and wherever possible, an imaginary 8-section, 2-layer grid (16 cells total) was superimposed on the load, and a randomly selected cell was identified for sampling. Approximately 250 pounds of waste from the cell were placed onto a tarp for sorting.

Each sample was sorted by hand into defined component groups as described in the tables that follow. Weights of all materials were also recorded on tally sheets.

Sampling from the Residential substream was determined to provide enough data to estimate the composition of paper categories within one to two percentage points and the composition of yard waste within four to five percentage points. Approximately 40 samples of residential waste were collected from the five districts that dispose the largest quantities of residential waste on Oahu (Koolauloa and Waialua were not included). Residential waste is disposed of at H-POWER.

Sampling for the Commercial substream provides enough data to estimate the composition of wood debris within five or six percentage points. Approximately 80 samples each from H-POWER and the Waimanalo Gulch Sanitary Landfill were taken.

Sampling for the Convenience Center substream was based on data collected for the residential substream. A total of 16 samples from H-POWER and 40 samples from Waimanalo Gulch were collected.

2.3.2 OVERALL WASTE COMPOSITION

In 1998, a total of 821,437 tons of waste was disposed by the residential, commercial, and convenience center substreams in the City & County (this total excludes construction and demolition waste). As shown in **Figure 2-2**, the most prevalent materials in the overall waste stream are paper, other organics (which includes food, carpeting, and textiles), and yard waste.

The paper, other organics, and yard waste categories account for well over half (63.5%) of the overall waste stream. The percentages may not add to 100 because of rounding.

Figure 2-2
Overview of Overall Waste Composition Results
March 1998 – February 1999

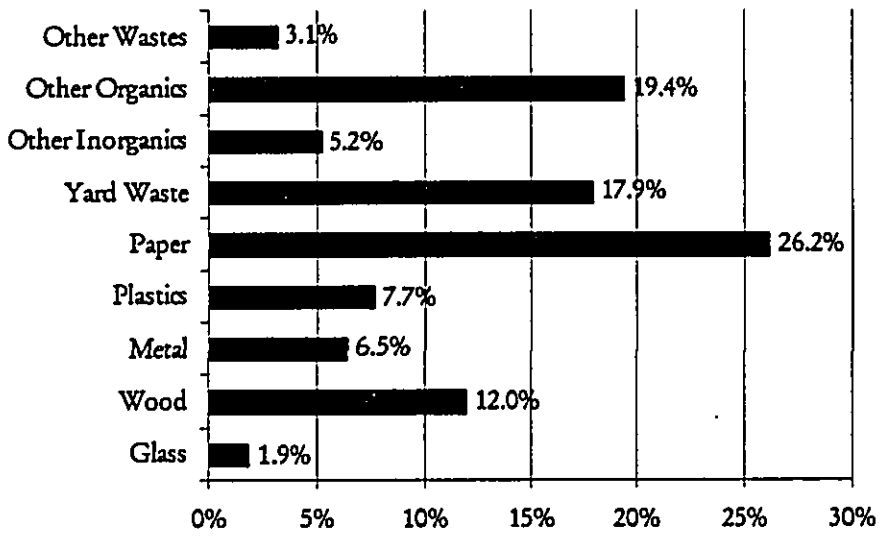


Table 2-1 identifies the detailed composition of the overall waste stream. The largest components, which account for nearly half (45.6%) of the overall waste stream, are listed below:

Table 2-1

Overall Waste Composition by Weight, City and County of Honolulu

March 1998 – February 1999

Calculated at 90% confidence interval	Composition Mean	+/-	Estimated Tons Mean	+/-
Paper	**26.2%**		**215,399**	
Newspaper	3.7%	0.3%	30,268	2,458
Cardboard	6.7%	0.7%	55,147	5,935
High Grade	1.6%	0.4%	13,242	3,517
Low Grade	9.0%	0.7%	73,594	5,486
Compostable	3.9%	0.6%	31,985	4,870
Other Paper	1.4%	0.2%	11,163	2,013
Plastics	**7.7%**		**63,056**	
PET #1 Bottles	0.4%	0.0%	3,380	392
HDPE #2 Bottles	0.4%	0.0%	3,694	311
Other Bottles	0.1%	0.0%	952	215
Other Rigid Plastic	2.4%	0.2%	19,435	1,790
Film Plastic	3.6%	0.4%	29,908	3,289
Mixed Plastic/Other Materials	0.7%	0.1%	5,687	1,214
Metal	**6.5%**		**53,741**	
Aluminum Cans	0.5%	0.0%	3,945	398
Tin Cans	0.9%	0.1%	7,473	811
Ferrous	2.2%	0.5%	17,801	4,042
NonFerrous	0.4%	0.2%	3,195	1,611
Mixed Metals/Other Materials	2.6%	0.6%	21,327	5,182
Glass	**1.9%**		**15,537**	
Glass Containers	1.6%	0.2%	13,054	1,374
Other Glass	0.3%	0.1%	2,484	1,130
Other Inorganics	**5.2%**		**42,648**	
Gypsum Wallboard	1.4%	0.5%	11,905	4,382
Asphalt Roofing	0.3%	0.3%	2,666	2,383
Asphalt Paving	0.3%	0.3%	2,625	2,801
Concrete	0.6%	0.4%	4,971	3,193
Sand/Soil/Dirt	0.9%	0.5%	7,452	3,745
Ceramic Products	0.2%	0.2%	2,013	1,746
Misc Inorganics	1.3%	0.6%	11,016	4,968
Other Wastes	**3.1%**		**25,386**	
Hazardous/Chemicals	0.3%	0.1%	2,816	1,008
Furniture/Mattresses	1.9%	0.6%	15,882	4,615
Brown Goods (appliances)	0.8%	0.5%	6,687	3,999
Yard Waste	**17.9%**		**147,047**	
Yard Waste	17.9%	1.7%	147,047	13,581
Wood	**12.0%**		**98,899**	
Untreated Lumber	1.8%	0.5%	14,401	4,197
Untreated Plywood	0.9%	0.4%	7,516	3,190
Pallets/Crates	4.8%	2.1%	39,292	17,059
Treated Wood	3.9%	0.9%	32,155	7,005
Stumps	0.7%	0.3%	5,535	2,693
Other Organics	**19.4%**		**159,724**	
Food	12.0%	1.1%	98,914	9,093
Textiles	1.7%	0.3%	14,362	2,601
Carpet	1.9%	0.8%	15,846	6,309
Tires	0.1%	0.1%	1,070	1,120
Misc Organics	3.6%	0.5%	29,532	3,867
Number of Samples/Total Tonnage	**428**		**821,437**	

Yard waste	17.9%	(147,047 tons)
Food	12.0%	(98,914 tons)
Low grade paper	9.0%	(73,594 tons)
Cardboard	6.7%	(55,147 tons)

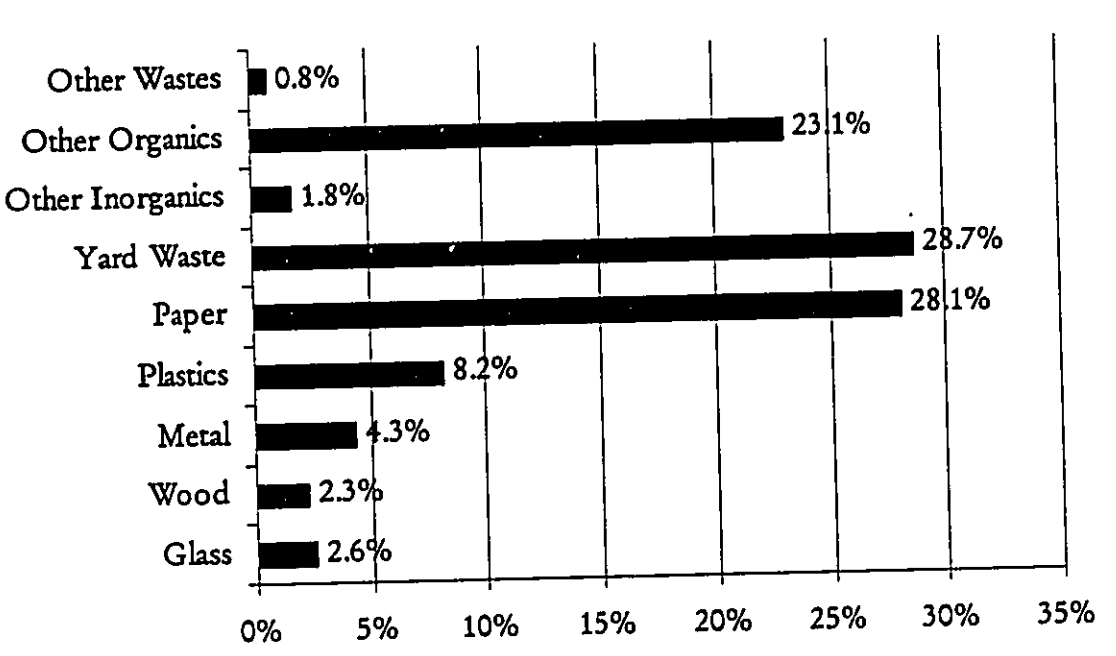
2.3.3 RESIDENTIAL WASTE COMPOSITION

In 1998, the residential substream comprised a total of 316,491 tons of waste. The overall residential composition results, by weight, for each of the disposal categories are indicated in **Figure 2-3.** As shown, paper, yard waste, and other organics (primarily food) accounted for 79.9% of the waste in the residential substream. Totals may not add to 100 percent because of rounding.

Figure 2-3

Overview of Overall Residential Sampling Results, by Weight

March – August 1998



Detailed analysis of each of these categories is presented in **Table 2-2.** The following four components accounted for well over half (62.0%) of the residential waste.

Table 2-2

Overall Residential Waste Composition, By Weight

March – August 1998

	Composition		Estimated Ton	
Calculated at 90% confidence interval	Mean	+/-	Mean	+/-
Paper	**28.1%**		**89,013**	
Newspaper	6.5%	0.5%	20,672	1,579
Cardboard	4.6%	0.4%	14,643	1,285
High Grade	1.1%	0.2%	3,542	725
Low Grade	11.4%	0.6%	35,993	1,815
Compostable	3.2%	0.2%	10,008	685
Other Paper	1.3%	0.2%	4,155	603
Plastics	**8.2%**		**26,012**	
PET #1 Bottles	0.5%	0.0%	1,562	126
HDPE #2 Bottles	0.7%	0.0%	2,161	144
Other Bottles	0.2%	0.0%	506	108
Other Rigid Plastic	2.4%	0.2%	7,536	512
Film Plastic	3.8%	0.2%	12,123	565
Mixed Plastic/Other Materials	0.7%	0.2%	2,125	580
Metal	**4.3%**		**13,653**	
Aluminum Cans	0.6%	0.1%	1,837	172
Tin Cans	1.2%	0.1%	3,804	293
Ferrous	0.7%	0.2%	2,352	653
NonFerrous	0.3%	0.1%	906	187
Mixed Metals/Other Materials	1.5%	0.3%	4,754	924
Glass	**2.6%**		**8,283**	**0**
Glass Containers	2.4%	0.2%	7,438	677
Other Glass	0.3%	0.2%	844	526
Other Inorganics	**1.8%**		**5,828**	
Gypsum Wallboard	0.2%	0.2%	716	750
Asphalt Roofing	0.1%	0.1%	338	183
Asphalt Paving	0.0%	0.0%	63	89
Concrete	0.2%	0.1%	496	274
Sand/Soil/Dirt	0.5%	0.2%	1,468	570
Ceramic Products	0.1%	0.1%	282	264
Misc Inorganics	0.8%	0.3%	2,466	811
Other Wastes	**0.8%**		**2,634**	
Hazardous/Chemicals	0.4%	0.2%	1,190	543
Furniture/Mattresses	0.1%	0.1%	302	218
Brown Goods (appliances)	0.4%	0.2%	1,142	613
Yard Waste	**28.7%**		**90,728**	
Yard Waste	28.7%	1.9%	90,728	6,086
Wood	**2.3%**		**7,258**	
Untreated Lumber	0.5%	0.1%	1,737	447
Untreated Plywood	0.1%	0.1%	243	189
Pallets/Crates	0.0%	0.0%	51	59
Treated Wood	1.0%	0.2%	3,169	760
Stumps	0.6%	0.3%	2,057	1,070
Other Organics	**23.1%**		**73,081**	
Food	15.4%	1.0%	48,766	3,036
Textiles	2.2%	0.3%	6,843	989
Carpet	0.9%	0.2%	2,849	736
Tires	0.0%	0.1%	154	180
Misc Organics	4.6%	0.4%	14,469	1,418
Number of Samples/Total Tonnage	211		316,491	

Yard waste	28.7%	(90,728 tons)
Food	15.4%	(48,766 tons)
Low grade paper	11.4%	(35,993 tons)
Newspaper	6.5%	(20,762 tons)

2.3.4 RESIDENTIAL WASTE COMPOSITION BY DISTRICT

Figure 2-4 identifies the approximate proportion of the total residential waste disposed of by district.

Figure 2-4
Proportion of Residential Waste Disposed by District
January - December 1998 (In Tons)

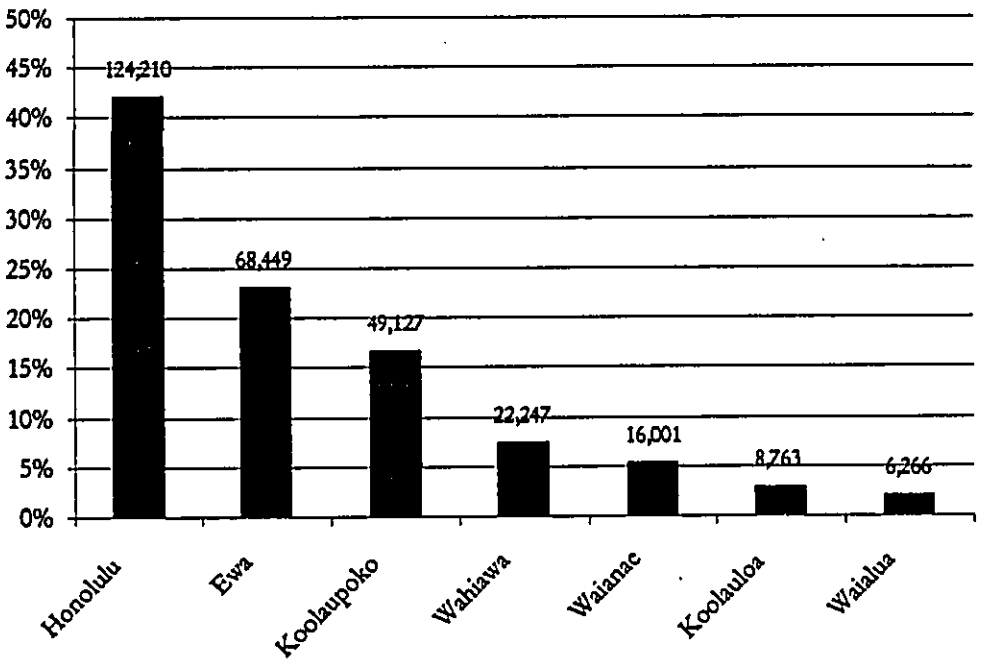
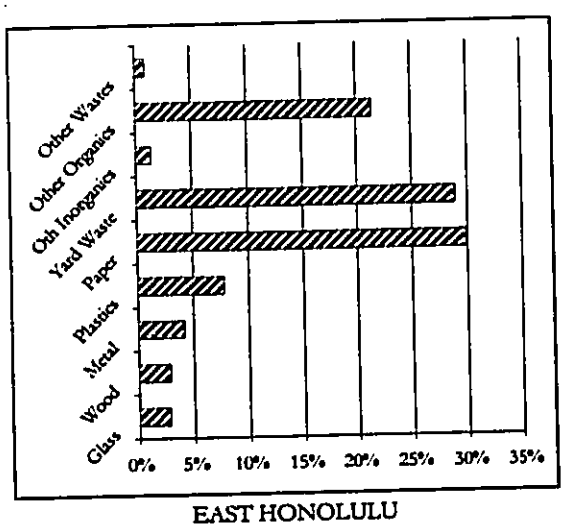
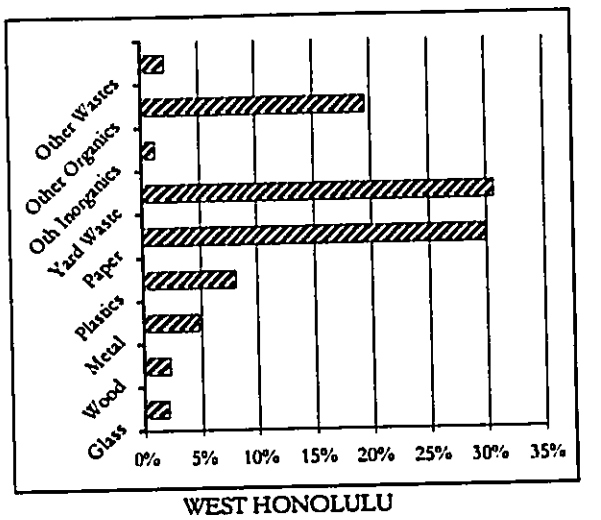


Figure 2-5 and **Table 2-3**, further identifies the detailed sorting results for each district. As shown in **Figure 2-5**, the composition percentages for each waste category are relatively similar among districts.

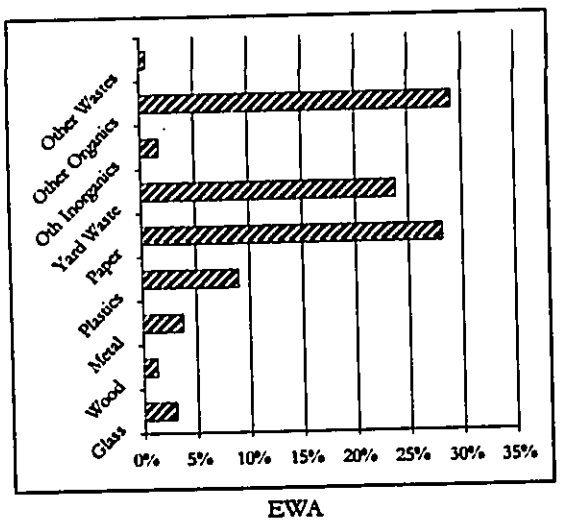
Figure 2-5
Overview of Residential Sampling Results, by District
March - August 1998



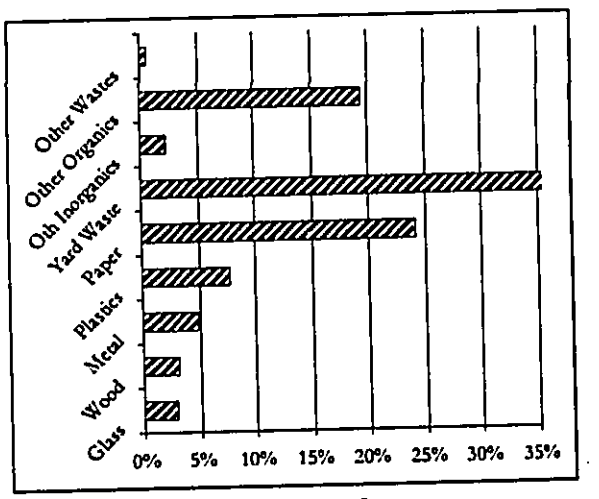
EAST HONOLULU



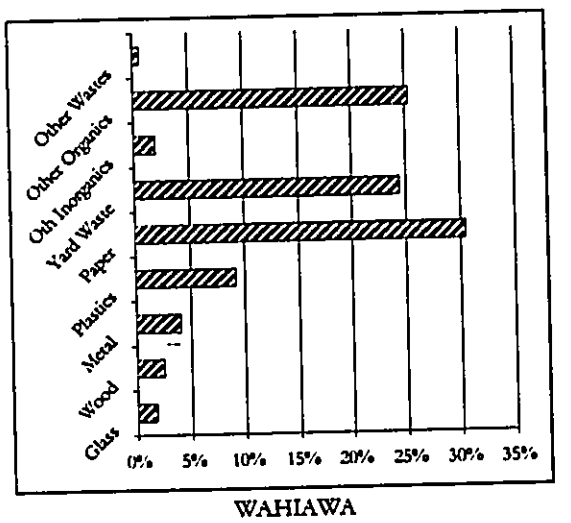
WEST HONOLULU



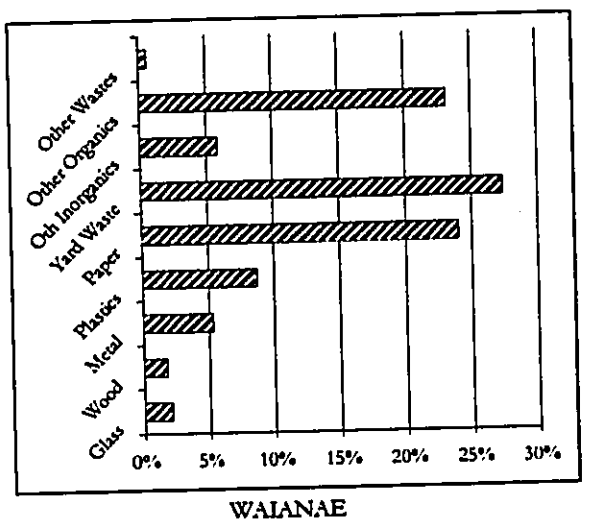
EWA



KOOLAUPOKO



WAHIAWA



WAIANAE

Table 2-3
Residential Waste Composition for Each District, by Weight
March - August 1998

Calculated at 90% confidence interval	E. Honolulu		W. Honolulu		Ewa		Koolaupoko		Wahiawa		Waianae	
	Mean	+/-	Mean	+/-	Mean	+/-	Mean	+/-	Mean	+/-	Mean	+/-
Paper	29.8%		29.9%		28.1%		24.1%		30.4%		24.0%	
Newspaper	7.9%	1.1%	8.0%	1.5%	5.5%	1.0%	4.8%	0.7%	6.5%	1.1%	5.5%	1.1%
Cardboard	4.8%	0.9%	4.4%	0.9%	4.9%	0.9%	3.8%	0.7%	5.5%	0.9%	4.4%	1.1%
High Grade	1.1%	0.2%	2.3%	1.2%	0.9%	0.4%	0.7%	0.2%	0.9%	0.9%	0.4%	0.2%
Low Grade	11.4%	1.3%	11.1%	1.2%	12.1%	1.3%	10.2%	1.0%	12.9%	1.5%	10.0%	1.1%
Compostable	3.0%	0.4%	2.9%	0.5%	3.9%	0.6%	3.0%	0.4%	3.2%	0.4%	2.3%	0.4%
Other Paper	1.6%	0.6%	1.2%	0.3%	0.9%	0.2%	1.5%	0.3%	1.3%	0.5%	1.4%	0.4%
Plastics	7.8%		8.0%		8.9%		7.7%		9.1%		8.7%	
PET #1 Bottles	0.5%	0.1%	0.4%	0.1%	0.5%	0.1%	0.5%	0.1%	0.6%	0.1%	0.5%	0.1%
HDPE #2 Bottles	0.6%	0.1%	0.7%	0.1%	0.7%	0.1%	0.6%	0.1%	0.8%	0.1%	0.8%	0.1%
Other Bottles	0.2%	0.0%	0.2%	0.1%	0.1%	0.1%	0.2%	0.1%	0.1%	0.0%	0.3%	0.2%
Other Rigid Plastic	2.1%	0.3%	2.3%	0.4%	2.5%	0.4%	2.4%	0.4%	2.8%	0.6%	2.4%	0.3%
Film Plastic	3.8%	0.4%	3.7%	0.5%	4.1%	0.4%	3.4%	0.3%	4.4%	0.4%	4.2%	0.3%
Mixed Plastic/Oth Matls	0.7%	0.3%	0.7%	0.3%	0.9%	0.6%	0.5%	0.1%	0.4%	0.2%	0.5%	0.2%
Metals	4.2%		4.7%		3.7%		4.8%		4.0%		5.3%	
Aluminum Cans	0.6%	0.1%	0.4%	0.1%	0.7%	0.1%	0.6%	0.1%	0.6%	0.1%	0.7%	0.1%
Tin Cans	1.2%	0.2%	1.1%	0.2%	1.4%	0.2%	1.0%	0.1%	1.2%	0.2%	1.6%	0.2%
Ferrous	0.8%	0.5%	0.7%	0.4%	0.5%	0.3%	0.9%	0.5%	1.0%	0.4%	0.8%	0.4%
NonFerrous	0.3%	0.2%	0.2%	0.1%	0.3%	0.1%	0.3%	0.1%	0.2%	0.1%	0.4%	0.2%
Mixed Metals/Oth Matls	1.4%	0.5%	2.4%	1.1%	0.8%	0.3%	2.0%	0.9%	1.1%	0.4%	1.8%	0.7%
Glass	2.8%		1.9%		3.0%		2.8%		1.8%		2.1%	
Glass Containers	2.6%	0.5%	1.7%	0.5%	2.5%	0.4%	2.7%	0.5%	1.7%	0.4%	2.0%	0.4%
Other Glass	0.2%	0.1%	0.3%	0.3%	0.5%	0.6%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
Other Inorganics	1.3%		1.2%		1.7%		2.0%		2.0%		5.8%	
Gypsum Wallboard	0.0%	0.0%	0.0%	0.0%	0.7%	0.9%	0.2%	0.3%	0.1%	0.1%	0.0%	0.0%
Asphalt Roofing	0.0%	0.0%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.4%	0.4%	0.4%	0.4%
Asphalt Paving	0.0%	0.0%	0.1%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Concrete	0.0%	0.0%	0.3%	0.3%	0.0%	0.0%	0.1%	0.1%	0.1%	0.1%	1.2%	1.3%
Sand/Soil/Dirt	0.5%	0.4%	0.1%	0.1%	0.2%	0.3%	0.0%	0.0%	0.5%	0.7%	3.8%	1.8%
Ceramic Products	0.1%	0.1%	0.0%	0.0%	0.2%	0.3%	0.1%	0.0%	0.0%	0.0%	0.0%	0.1%
Misc Inorganics	0.7%	0.4%	0.5%	0.4%	0.6%	0.7%	1.5%	0.7%	0.9%	0.7%	0.3%	0.2%
Other Wastes	0.8%		2.0%		0.5%		0.5%		0.6%		0.5%	
Hazardous/Chemicals	0.6%	0.6%	0.3%	0.2%	0.1%	0.1%	0.3%	0.2%	0.5%	0.5%	0.4%	0.2%
Furniture/Mattresses	0.0%	0.0%	0.3%	0.3%	0.2%	0.2%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%
Brown Goods (appliances)	0.2%	0.2%	1.4%	1.1%	0.2%	0.2%	0.2%	0.3%	0.0%	0.0%	0.1%	0.1%
Yard Waste	28.9%		30.6%		23.8%		35.7%		24.3%		27.3%	
Yard Waste	28.9%	5.0%	30.6%	3.9%	23.8%	3.5%	35.7%	3.9%	24.3%	3.7%	27.3%	3.2%
Wood	2.9%		2.1%		1.3%		3.0%		2.5%		1.7%	
Untreated Lumber	0.6%	0.3%	0.4%	0.2%	0.6%	0.3%	0.7%	0.3%	0.4%	0.3%	0.2%	0.1%
Untreated Plywood	0.2%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Pallets/Crates	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.0%	0.0%	0.1%	0.2%
Treated Wood	1.3%	0.7%	0.8%	0.3%	0.7%	0.3%	1.1%	0.5%	1.4%	1.1%	0.6%	0.3%
Stumps	0.7%	0.8%	1.0%	1.1%	0.0%	0.0%	1.2%	1.0%	0.7%	0.8%	0.7%	0.9%
Other Organics	21.4%		19.5%		29.0%		19.4%		25.3%		24.7%	
Food	15.0%	2.4%	13.1%	1.7%	19.0%	2.1%	13.3%	1.5%	17.1%	2.6%	12.9%	1.7%
Textiles	2.4%	0.7%	2.4%	1.0%	1.9%	0.5%	1.8%	0.5%	2.3%	0.9%	2.6%	1.0%
Carpet	0.6%	0.3%	0.6%	0.5%	1.6%	0.8%	0.7%	0.3%	0.8%	0.3%	1.3%	0.4%
Tires	0.0%	0.0%	0.2%	0.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Misc Organics	3.4%	1.0%	3.3%	0.7%	6.6%	1.1%	3.6%	0.7%	5.1%	1.0%	7.8%	1.7%
Number of Samples	40		25		36		40		35		35	

The proportion of yard waste was slightly higher at Koolaupoko (35.7%) than the other districts. Ewa and Wahiawa had the lowest proportions of yard waste (23.8% and 24.3%, respectively). In East Honolulu, West Honolulu and Waianae, yard waste ranged from 27.3% to 30.6%.

Paper constituted a slightly lower proportion of waste in Koolaupoko and Waianae (24.0-24.1%), than other districts (28.1-30.4%). The proportion of other organics (which includes food and textiles) at East Honolulu, West Honolulu, and Koolaupoko (19.5-21.4%) were slightly less than at Ewa, Wahiawa, and Waianae (24.7-29.0%). In these districts, the higher percentages of other organics were primarily due to higher amounts of food and miscellaneous organics[2]. Chart percentages in **Figure 2-5** may not add to 100 because of rounding.

The largest components (each accounting for at least 5% of the total tonnage) for each collection district (with the Honolulu district divided into east and west areas) are shown in **Table 2-4**. Various paper grades, yard waste and food waste were prevalent in each district. "Miscellaneous organics" includes such items as diapers and animal wastes.

Table 2-4
Largest Residential Waste Components, by District
March - August 1998

	East Honolulu	West Honolulu	Ewa	Koolaupoko	Wahiawa	Waianae
Newspaper	7.9%	8.0%	5.5%	4.8%	6.5%	5.5%
Cardboard	4.8%	4.4%	4.9%	3.8%	5.5%	4.4%
Low Grade Paper	11.4%	11.1%	12.1%	10.2%	12.9%	10.0%
Yard Waste	28.9%	30.6%	23.8%	35.7%	24.3%	27.3%
Food	15.0%	13.1%	19.0%	13.3%	17.1%	12.9%
Misc. Organics	3.4%	3.3%	6.6%	3.6%	5.1%	7.8%

[2] No statistical tests were performed to compare residential composition results by district.

2.3.5 COMMERCIAL WASTE COMPOSITION

Commercial waste is collected by non-Refuse Division vehicles, including private commercial waste haulers, other City & County of Honolulu departments, and the public (individuals and self-haulers)[3]. In 1998, the commercial substream disposed a total of 477,770 tons of waste (341,563 at H-POWER and 136,207 at Waimanalo Gulch).

Overall commercial composition results, by weight, are illustrated in **Figure 2-6**. As shown, the paper, other organics (including food, carpeting, and textiles), and wood categories accounted for 61.4% of the overall commercial waste. The percentages may not add to 100 because of rounding.

Figure 2-6
Overview of Commercial Waste, by Weight
March - August 1998

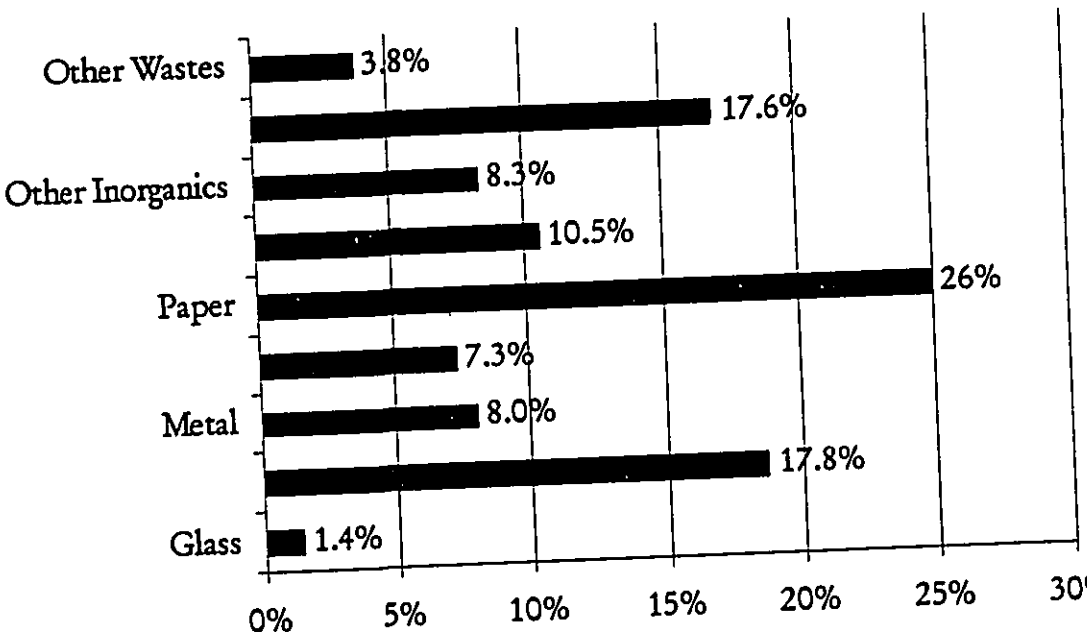


Table 2-5 provides detailed composition results. The following six components accounted for over half (50.6%) of the overall waste in the commercial substream:

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[3] Small residential self-haul were not sampled (i.e., they were not part of the sampling universe.)

Table 2-5
Overall Commercial Waste Composition, by Weight
March - August 1998

Calculated at 90% confidence interval	Composition Mean	+/-	Estimated Tons Mean	+/-
Paper	**26.0%**		**124,445**	
Newspaper	2.0%	0.4%	9,370	1,880
Cardboard	8.3%	1.2%	39,802	5,791
High Grade	2.0%	0.7%	9,628	3,441
Low Grade	7.8%	1.1%	37,121	5,175
Compostable	4.6%	1.0%	21,837	4,821
Other Paper	1.4%	0.4%	6,686	1,904
Plastics	**7.5%**		**35,794**	
PET #1 Bottles	0.4%	0.1%	1,800	372
HDPE #2 Bottles	0.3%	0.1%	1,520	275
Other Bottles	0.1%	0.0%	444	187
Other Rigid Plastic	2.3%	0.4%	11,177	1,691
Film Plastic	3.7%	0.7%	17,589	3,239
Mixed Plastic/Other Materials	0.7%	0.2%	3,264	1,058
Metal	**7.7%**		**36,977**	
Aluminum Cans	0.4%	0.1%	2,056	358
Tin Cans	0.8%	0.2%	3,609	755
Ferrous	3.0%	0.8%	14,294	3,962
NonFerrous	0.5%	0.3%	2,187	1,599
Mixed Metals/Other Materials	3.1%	1.1%	14,830	5,073
Glass	**1.5%**		**7,087**	
Glass Containers	1.2%	0.2%	5,535	1,194
Other Glass	0.3%	0.2%	1,552	998
Other Inorganics	**7.4%**		**35,588**	
Gypsum Wallboard	2.3%	0.9%	10,850	4,312
Asphalt Roofing	0.4%	0.5%	2,049	2,358
Asphalt Paving	0.5%	0.6%	2,562	2,800
Concrete	0.9%	0.7%	4,366	3,177
Sand/Soil/Dirt	1.2%	0.8%	5,857	3,697
Ceramic Products	0.3%	0.4%	1,619	1,719
Misc Inorganics	1.7%	1.0%	8,284	4,895
Other Wastes	**3.6%**		**17,191**	
Hazardous/Chemicals	0.3%	0.2%	1,596	848
Furniture/Mattresses	2.2%	0.9%	10,519	4,458
Brown Goods (appliances)	1.1%	0.8%	5,076	3,943
Yard Waste	**10.8%**		**51,778**	
Yard Waste	10.8%	2.5%	51,778	12,087
Wood	**17.8%**		**84,964**	
Untreated Lumber	2.5%	0.9%	11,769	4,161
Untreated Plywood	1.4%	0.7%	6,829	3,164
Pallets/Crates	8.1%	3.6%	38,927	17,056
Treated Wood	5.2%	1.4%	24,960	6,887
Stumps	0.5%	0.5%	2,479	2,402
Other Organics	**17.6%**		**83,946**	
Food	10.4%	1.8%	49,536	8,568
Textiles	1.4%	0.5%	6,926	2,393
Carpet	2.5%	1.3%	12,091	6,234
Tires	0.1%	0.2%	659	1,081
Misc Organics	3.1%	0.8%	14,734	3,588
Number of Samples/Total Tonnage	161		477,770	

Yard waste	10.8%	51,778 Tons
Food	10.4%	49,536 Tons
Cardboard	8.3%	39,802 Tons
Pallets/crates	8.1%	38,927 Tons
Low grade paper	7.8%	37,121 Tons
Treated wood	5.2%	24,960 Tons

Unlike residential waste, the composition of commercial waste disposed between Waimanalo Gulch Sanitary Landfill and H-POWER are very different. As shown, the paper and other organics (which includes food and textiles) categories accounted for the bulk of the waste hauled to H-POWER (53.6%). At Waimanalo Gulch, paper and other organics, only accounted for 18.5% of the waste. The difference between the other organics categories is primarily a result of more food waste at H-POWER.

At Waimanalo Gulch, the wood and other inorganics (which includes various construction debris) categories accounted for the bulk of the commercial waste (51.2%). At H-POWER, wood and other inorganics only accounted for 14.8% of the waste. The greater proportions of gypsum wallboard, sand/soil/dirt, and concrete at Waimanalo Gulch result in the higher percentage for the other inorganics category[4].

Yard waste accounted for a higher proportion of waste at H-POWER, and metal accounted for a higher proportion of waste at Waimanalo Gulch. **Figure 2-7** summarizes the results for each facility. The percentages may not add to 100 because of rounding.

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[4] No statistical tests were performed to compare the commercial composition results, between sites, as described in Section 6.2.

Figure 2-7
Overview of Commercial Waste, by Site
March - August 1998

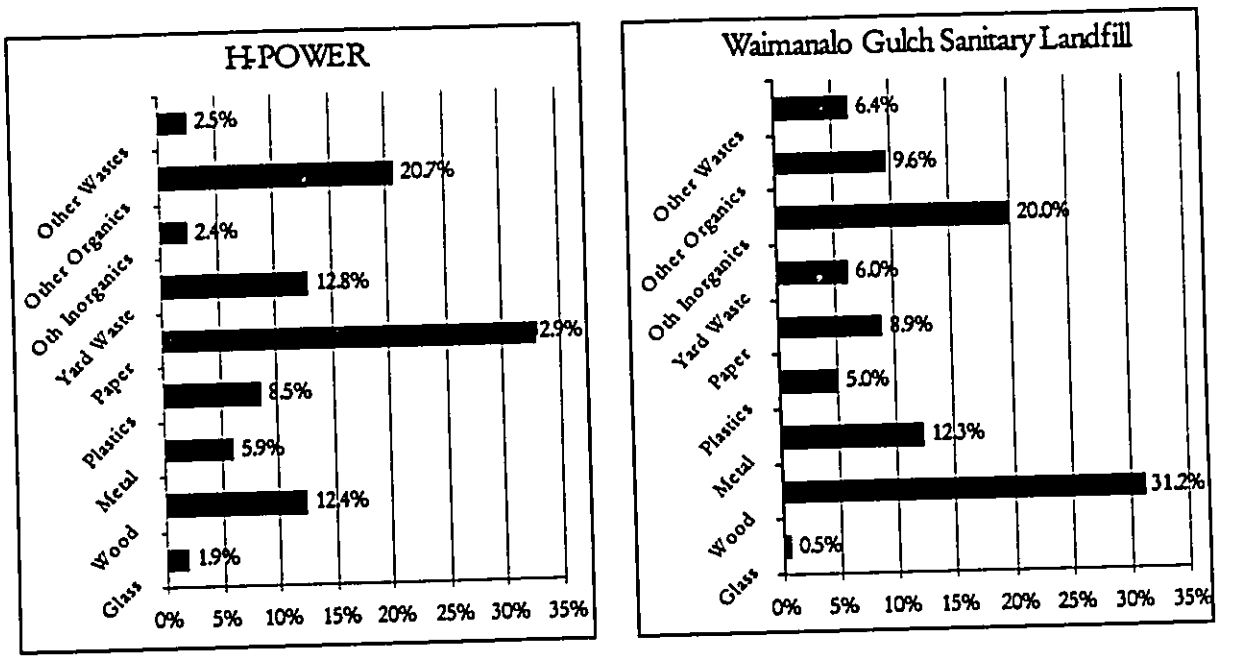


Table 2-6 shows the largest components (greater than 5%) for each facility in the commercial substream. Cardboard, yard waste, and pallets/crates were prevalent at both sites. Similar to the residential substream, various paper grades and food waste accounted for substantial portions of the H-POWER commercial tonnage.

Table 2-6
Largest Commercial Components, by Weight
March – August 1998

	H-POWER	Waimanalo
Cardboard	9.6%	5.2%
Low Grade Paper	10.0%	
Compostable Paper	6.3%	
Ferrous Metal		6.7%
Yard Waste	12.8%	6.0%
Gypsum Wallboard		7.0%
Furniture/Mattress		5.1%
Untreated Lumber		5/8%
Pallets/Crates	8.4%	7.6%
Treated Wood		13.9%
Food	13.9%	

2.3.5 CONVENIENCE CENTER GENERATED WASTE

In 1998, a total of 27,176 tons of waste was deposited at the convenience centers (2,122 at H-POWER and 25,054 at Waimanalo Gulch). Combustible waste is sent to H-POWER and the non-combustible waste is sent to recyclers or Waimanalo Gulch.

Composition estimates for the overall convenience center substream are shown in **Figure 2-8.** As shown, the wood, the other wastes (primarily furniture/mattresses), and the yard waste categories accounted for 61.8% of the waste. The percentages may not add to 100 because of rounding.

Figure 2-8

Overview of Overall Convenience Center Sampling, by Weight

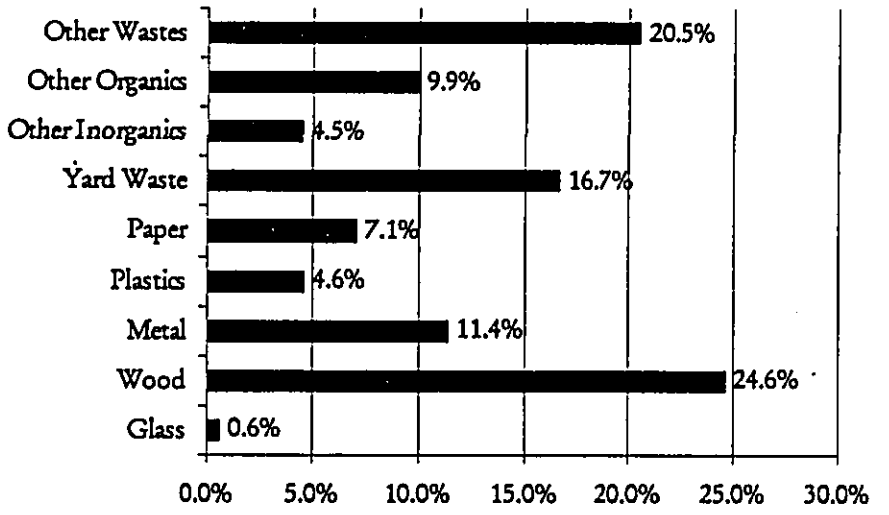


Table 2-7 presents the detailed results for the overall convenience center substream. Over half of the waste (50.1%) consisted of the following four components.

Furniture/mattresses	18.6%	5,061 Tons
Yard waste	16.7%	4,541 Tons
Treated wood	14.8%	4,026 Tons
Mixed metals/Oth matls	6.3%	1,743 Tons

Table 2-7
Overall Convenience Centers Waste Composition, By Weight
May 1998 – February 1999

	Composition		Estimated Tons	
Calculated at 90% confidence interval	*Mean*	*+/-*	*Mean*	*+/-*
Paper	**7.1%**		**1,940**	
Newspaper	0.8%	0.4%	226	122
Cardboard	2.6%	0.7%	701	190
High Grade	0.3%	0.3%	71	79
Low Grade	1.8%	0.5%	480	147
Compostable	0.5%	0.4%	140	99
Other Paper	1.2%	0.9%	322	261
Plastics	**4.6%**		**1,250**	
PET #1 Bottles	0.1%	0.0%	18	10
HDPE #2 Bottles	0.0%	0.0%	12	6
Other Bottles	0.0%	0.0%	3	2
Other Rigid Plastic	2.7%	1.0%	722	292
Film Plastic	0.7%	0.2%	197	63
Mixed Plastic/Other Materials	1.1%	0.5%	298	141
Metal	**11.4%**		**3,110**	
Aluminum Cans	0.2%	0.1%	52	31
Tin Cans	0.2%	0.1%	59	39
Ferrous	4.3%	1.7%	1,155	474
NonFerrous	0.4%	0.2%	101	64
Mixed Metals/Other Materials	6.4%	1.9%	1,743	532
Glass	**0.6%**		**168**	
Glass Containers	0.3%	0.2%	80	51
Other Glass	0.3%	0.2%	87	54
Other Inorganics	**4.5%**		**1,233**	
Gypsum Wallboard	1.2%	0.8%	339	229
Asphalt Roofing	1.0%	1.1%	279	295
Asphalt Paving	0.0%	0.0%	0	0
Concrete	0.4%	0.6%	108	160
Sand/Soil/Dirt	0.5%	0.6%	128	174
Ceramic Products	0.4%	0.6%	112	164
Misc Inorganics	1.0%	1.0%	266	267
Other Wastes	**20.5%**		**5,561**	
Hazardous/Chemicals	0.1%	0.1%	31	30
Furniture/Mattresses	18.6%	4.3%	5,061	1,205
Brown Goods (appliances)	1.7%	1.0%	469	269
Yard Waste	**16.7%**		**4,541**	
Yard Waste	16.7%	4.2%	4,541	1,167
Wood	**24.6%**		**6,678**	
Untreated Lumber	3.3%	1.1%	895	316
Untreated Plywood	1.6%	1.3%	444	370
Pallets/Crates	1.2%	1.1%	314	296
Treated Wood	14.8%	3.8%	4,026	1,057
Stumps	3.7%	2.1%	999	594
Other Organics	**9.9%**		**2,696**	
Food	2.3%	0.9%	612	243
Textiles	2.2%	0.9%	592	256
Carpet	3.3%	2.3%	906	653
Tires	0.9%	0.9%	258	237
Misc Organics	1.2%	0.9%	329	258
Number of Samples/Total	**56**		**27,176**	

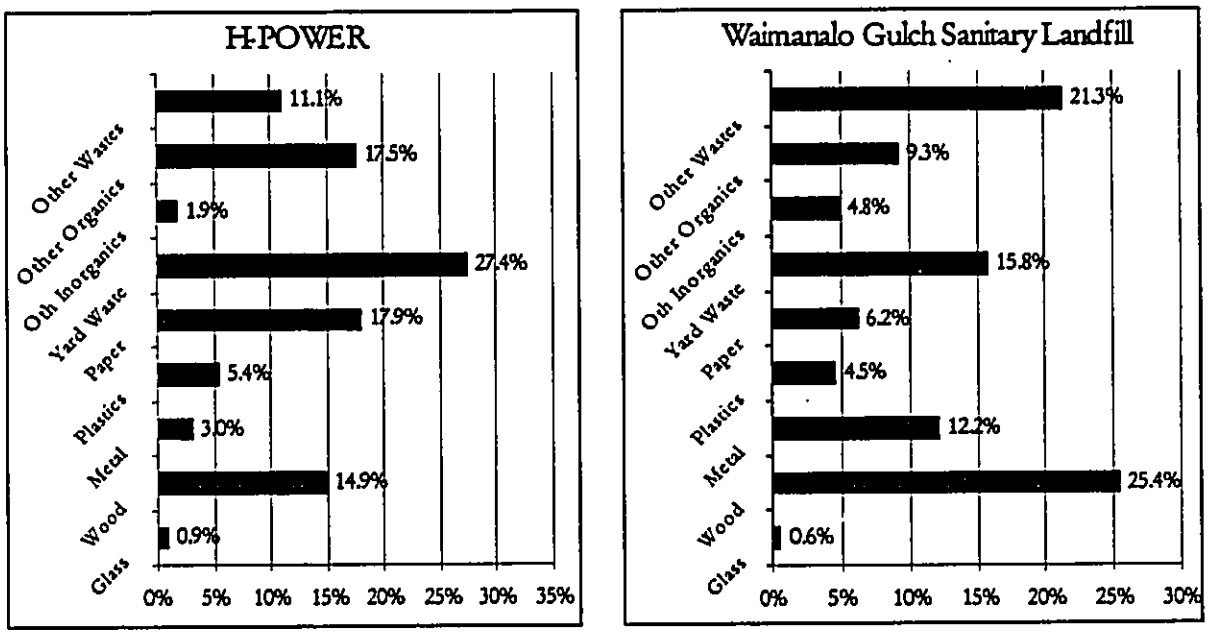
Figure 2-9 summarizes the sorting results completed at H-POWER and Waimanalo Gulch. As shown, yard waste was the largest waste type disposed at H-POWER from convenience centers (27.4%), followed by the paper (17.9%), other organics (17.5%), and wood categories (14.9%). At Waimanalo Gulch, the wood, other wastes (which includes furniture/mattresses and hazardous materials), and yard waste categories accounted for the majority of the waste (62.5%).

The greater proportion of cardboard and low grade paper accounted for the higher proportion of paper at H-POWER. At Waimanalo Gulch, the higher proportion of other wastes and wood resulted from the greater amount of furniture/mattresses and treated wood, respectively.[5] The percentages may not add to 100 because of rounding.

Figure 2-9

Overview of Convenience Center Sampling, by Site

May 1998 - February 1999



[5] No statistical tests were performed to compare the convenience center composition results between sites, as described in Section 7.2.

SECTION 3
ALTERNATIVE TECHNOLOGIES FOR WASTE DISPOSAL

3.1 BACKGROUND

A study on alternative technologies for the disposal of solid waste was commissioned by ENV as part of the Oahu Municipal Refuse Disposal Alternatives Study. In April 2000, the findings of the study were provided in the report, New Systems Research for Refuse Disposal. The purpose of the report was to investigate new and innovative technologies that could reduce dependency on use of sanitary landfills such as Waimanalo Gulch. Selected portions of the study for evaluation of potential new alternatives are provided in this report in subsections 3.2 through 3.6. Subsection 3.7, provides a summary of issues that will need to be addressed before adoption of the alternative.

A brief description of each of the subsections follows:

3.2 Oahu Municipal Refuse Management System and Modeling

A model of the refuse management system was developed to identify physical facilities, recycled waste streams, and material processing rates at key refuse facilities including transfer stations, convenience centers, H-POWER, and the Waimanalo Gulch Sanitary Landfill.

3.3 First Tier Screening of Alternative Technologies

A survey of potential new technologies was completed to ascertain the availability of new systems. This initial list of alternatives was subject to a preliminary "first tier screening" to identify seven of the most feasible options. The screening criteria were based on requirements of ENV and technological considerations.

3.4 Second Tier Screening of Alternative Technologies

The first tier alternatives were subject to a "second tier screening" evaluation. The second tier screening produced three short-listed technologies for detailed evaluation.

3.5 Facility Concepts for Alternative Technologies

Each of the short-listed technologies was further analyzed to ascertain requirements for incorporation into the existing municipal waste management system. A preliminary design package was developed for each of the three alternatives and includes functional, operational, and performance characterization of each facility.

3.6 Evaluation of Alternative Technologies

The final evaluation involved review of a number of final factors which included:

- Application to the existing municipal waste management system
- Existing system changes required to adopt the new system
- Project development activities and estimated duration
- Milestones
- Prior experience
- Permitting issues
- Operational reliability
- Implementation barriers and incentives
- Waste diversion capability
- Economic feasibility

3.7 Summary

A summary is provided to review issues which will need to be addressed before alternative technologies identified in the Oahu Municipal Refuse Disposal Alternatives Study can be considered for future use and development.

3.2 OAHU MUNICIPAL REFUSE MANAGEMENT SYSTEM AND MODELING

A refuse system model was developed based on existing City conditions as of September 1998. A conceptual diagram of the model is provided in **Figure 3-1.** The following is a summary outline of the system, also described in Chapter 2 - Waste Stream Composition Overview.

3.2.1 OAHU MUNICIPAL REFUSE MANAGEMENT SYSTEM

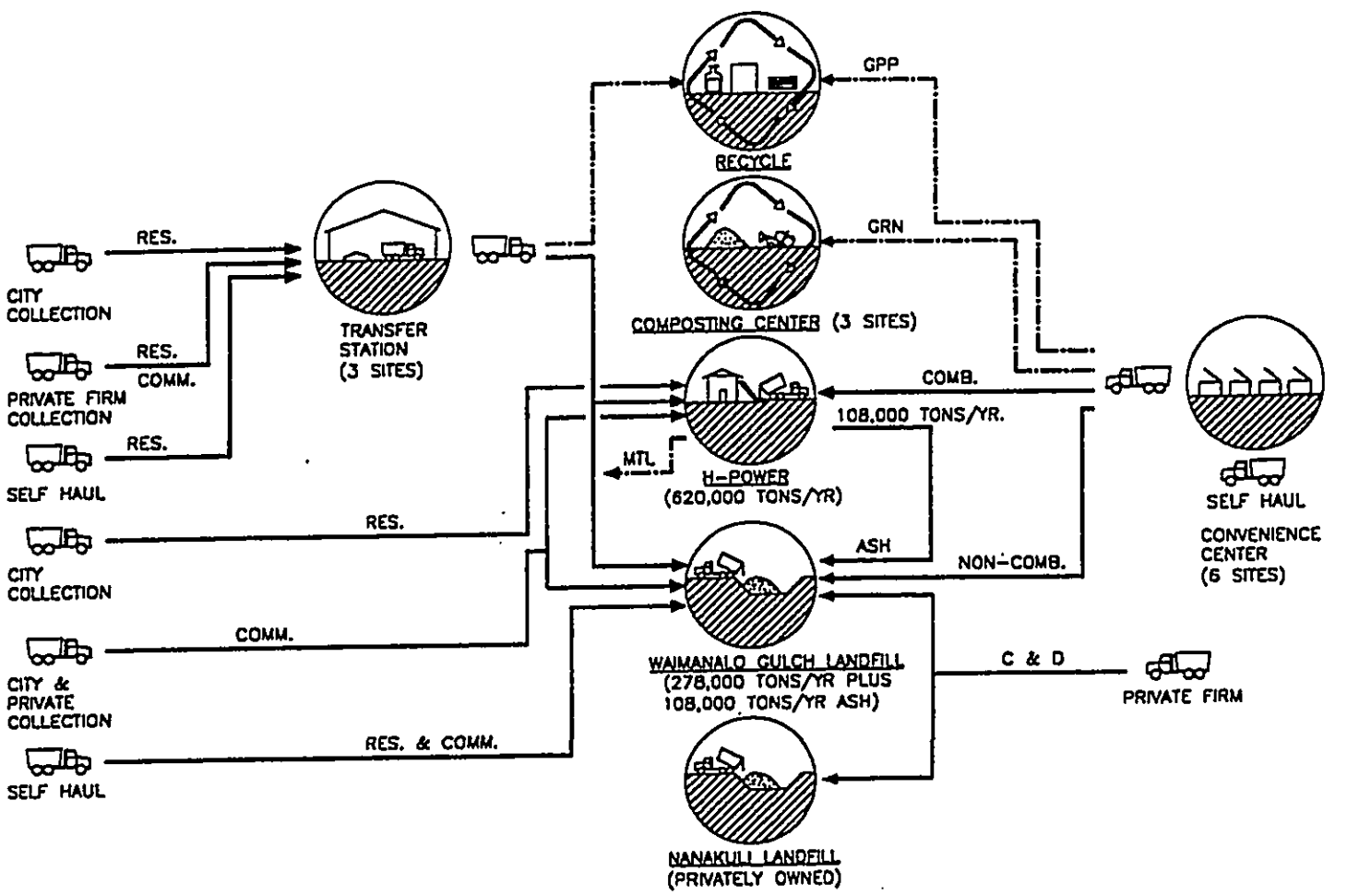
3.2.1.1 COLLECTION SYSTEM

Waste from each of the City's seven collection districts is either sent through one of three transfer stations or hauled directly to the disposal site, depending on distance from the route to the disposal point. The three Transfer Stations include:

Keehi Refuse Transfer Station - The Keehi Refuse Transfer Station is located on a 5-acre site in Honolulu. The facility serves the most populous area of Oahu and has been operational since 1977.

Kapaa Refuse Transfer Station - Kapaa Refuse Transfer Station is located on a site formerly mined as a rock quarry by Ameron HC&D. This transfer station began operation in 1989.

Kawailoa Refuse Transfer Station - Kawailoa Refuse Transfer Station is located next to the closed Kawailoa Sanitary Landfill. This transfer station began operation in 1987.



LEGEND
RES. = RESIDENTIAL WASTE
COMM. = COMMERCIAL WASTE
GRN. = GREEN WASTE
GPP. = GLASS, PAPER, PLASTIC
NON-COMB. = NON-COMBUSTIBLE WASTE
COMB. = COMBUSTIBLE WASTE
C & D = CONSTRUCTION & DEMOLITION
MTL. = METAL RECYCLE
——— EXISTING DISPOSAL FLOW
—·—·— EXISTING RECYCLE FLOW

FIGURE 3-1
Block Diagram of Existing Refuse Management System Model

Alternatives Analysis for Disposal of Municipal Solid Waste (MSW)
Dept. Of Environmental Services (ENV) • C & C Honolulu
Waste Management of Hawaii, Inc.

R. M. TOWILL CORPORATION

Source: *New Systems Research for Refuse Disposal,* C & C Honolulu, ENV, April 2000

In addition, the City operates a system of six convenience centers where householders can drop off waste. The centers have bins designated for recycling, H-POWER, and landfill. The customer places the waste in the proper bin.

3.2.1.2 WASTE RECYCLING / WASTE DIVERSION

The City's waste recycling programs include the following components:

- Recycling Drop-Off Centers
- Citizen Sponsored Recycling
- Restaurant Food Waste Recycling
- City Program for Office Recycling
- Incentive-Induced Glass Recycling
- Green Waste Drop-Off Centers
- Restaurant Glass Recycling
- Office Paper Waste Recycling
- Construction Debris Recycling
- Ferrous and Non-Ferrous Metal Recycling

3.2.1.3 DISPOSAL

The City operates two disposal facilities, and a third is privately operated. These facilities include:

Waimanalo Gulch Sanitary Landfill - This landfill is located at Waimanalo Gulch in Kapolei, Oahu. It is owned by the City and operated by Waste Management of Hawaii, Inc.

H-POWER Waste-to-Energy Plant.- The City's H-POWER facility located in Campbell Industrial Park is a refuse-derived fuel plant that produces energy from combusted solid waste. It is operated by Honolulu Resource Recovery Venture, Inc.

PVT Landfill - The PVT Landfill is located in Nanakuli, Oahu. It is owned and operated by the PVT Land Company and is permitted to accept refuse from construction and demolition activities.

3.2.2 REFUSE COMPOSITION AND DISPOSAL RATES

Table 3-1 provides 1998 waste composition data for the Waimanalo Gulch Sanitary Landfill waste stream. The data was obtained from the Waste Composition Study, described in Chapter 2.

H-POWER - The H-POWER facility currently processes about 620,000 tons of waste per year (about 2,000 tons per day).

Waimanalo Gulch Sanitary Landfill - The amount of municipal solid waste disposed of at the Waimanalo Gulch Sanitary Landfill in 1998 was 192,099 tons. For the purposes of this analysis, it is assumed that this waste is processible.

Private Landfill - PVT Land Company accepts approximately 355,000 tons per year of refuse from construction and demolition activities.

3.3 FIRST TIER SCREENING OF ALTERNATIVE TECHNOLOGIES

3.3.1 TECHNOLOGY SURVEY

A survey of refuse recycling technologies was conducted to identify state-of-the-art and innovative ideas for volume reduction and recycling of refuse currently being sent to Waimanalo Gulch Landfill. The survey identified over 50 recycling methods from the following sources:

TABLE 3-1

Composition of Refuse Received at Waimanalo Gulch Sanitary Landfill

1998

MATERIAL	COMPOSITION (mean %)	TONS
Paper	**8.9%**	**17,097**
Newspaper	0.2%	384
Cardboard	5.2%	9,989
High Grade	0.5%	960
Low Grade	2.2%	4,226
Compostable	0.3%	576
Non-Recyclable Paper	0.5%	960
Plastics	**5.0%**	**9,605**
PET #1	0.0%	0
HDPE #2	0.0%	0
Other Bottles	0.0%	0
Rigid Plastic	1.4%	2,689
Film Plastic	2.5%	4,802
Other Plastic	1.0%	1,921
Wood	**31.2%**	**59,935**
Treated Wood	13.9%	26,702
Pallets/Crates	7.6%	14,600
Untreated Lumber	5.8%	11,142
Untreated Plywood	2.6%	4,995
Stumps	1.3%	2,497
Metal	**12.3%**	**23,628**
Aluminum Cans	0.2%	384
Tin Cans	0.2%	384
Ferrous	6.7%	12,871
Non-ferrous	0.4%	768
Mixed/Other	4.8%	9,221
Glass	**0.5%**	**960**
Yard Waste	**6.0%**	**11,526**
Other Inorganics	**20.0%**	**38,420**
Wallboard	7.0%	13,447
Asphalt Roofing	1.4%	2,689
Asphalt Paving	1.9%	3,650
Concrete	2.9%	5,571
Other	6.8%	13,063
Other Wastes	**16.0%**	**30,736**
Furniture/Mattresses	5.1%	9,797
Carpet	4.5%	8,644
Other	6.4%	12,294
TOTAL	**100%**	**192,099**

Note: Composition data are calculated at 90% confidence interval

Municipal Solid Waste Programs - A survey of various municipal solid waste systems was conducted to obtain information on new technologies that have been considered by municipalities in the United States.

Literature Survey - A literature survey (EPA, state and municipalities) was conducted to identify existing, new and emerging technologies implemented or proposed for municipal waste reduction.

Vendor Survey - Vendors were contacted to obtain data on proposed waste management technologies.

Information on technologies obtained during the survey have been compiled in the Appendix-Vendor and Technology Information, New Systems Research for Refuse Disposal, Oahu Municipal Refuse Disposal Alternatives Study, April 2000.

3.3.2 CRITERIA USED FOR FIRST-TIER SCREENING OF TECHNOLOGIES

The purpose of the first-tier screening process was to reduce the number of technologies identified during the survey to approximately seven. This screening process was performed through a figure-of-merit (FOM) evaluation method. This method involves first defining a set of screening criteria and then scoring each option against the given criteria. The criteria used for FOM screening are as follows:

Volume Reduction - The ability of the system to reduce the volume of waste to be placed in the municipal landfills.

Recycling - The ability of the system to recover resources for recycling and reuse.

Disposal Site Impact - The ability of the system to minimize impact on the disposal media. For example, a desirable system would maximize long-term disposal site stability and reduce: 1) dispersion of material at the disposal site areas; 2) toxicity of waste and minimize leakage into groundwater; 3) subsidence; and, 4) generation of gas.

Adaptability - Ease of adoption within the existing City refuse management system. Alternatives requiring an immediate drastic change could be cost prohibitive or impractical.

Worker Safety - The ability of the system to be operated by the City or contract workers within acceptable safety standards.

Availability - The level of maturity of the system and degree to which the system can be immediately applied are evaluated by this criterion. Systems that are fully developed, operational, time proven, and commercially available would rate a higher score than emerging, unproven technologies. A system with technology elements that have only lab scale or prototype application histories would not qualify under this criterion.

Protection of the Public Health and Safety - The degree to which the system is able to ensure public health and safety.

Complexity - The degree of complexity of the system and its ease of operation and maintenance. Simpler systems are desirable because of less possibility of failure, higher operational availability, and higher levels of efficiency.

Versatility - The ability of the system to handle the expected waste stream. The physical characteristics of typical waste streams could vary widely. Versatile systems that accept a wide range of waste would rate a higher score than those having limitations requiring extensive sorting and segregation.

Environmental Friendliness - The measurement of environmental friendliness will depend on the impact of the technology on human health and the environment. Technologies that minimize air emissions, discharges to surface waters, and risk of releasing toxic material to the groundwater are generally defined as "environmentally friendly" technologies.

Technical Risk - Technical risk addresses the probability of the technology to produce the expected results and performance. For example, a technology may appear to be technically sound for some waste streams, but adoption to another waste stream may require a major redesign that could bring additional complexity and uncertainty.

Regulatory/ Permitting Risks - The degree of uncertainty involved with the ability to obtain a construction and operating permit for the technology. The extent and complexity of permitting will depend on air emissions and any discharge to surface waters. Systems that have minimal air emissions and zero liquid discharge are the most desirable approach. Technologies that minimize potential leakage into the groundwater will receive a high score. Also, proven past permitting will be considered as a positive point.

Economic Risks - The lifecycle cost performance for the technology will be defined. The economic risk criteria addresses the degree of confidence regarding the system's ability to perform within the estimated life-cycle costs. For example, if a technology has already been commercialized and has had previous operating experience, it is reasonable to assume that its cost can be quantified within a reasonable level of certainty. A complex system with unknown factors relative to capital, operating, and

maintenance costs, would increase risks associated with cost overruns. Such a system would receive a low score.

Schedule Risks - This criterion evaluates the degree of uncertainty associated with acquiring and implementing a given technology. For example, if a system is still in the research and development stage, the probability of commercializing such a system within the given time-frame might be lower than a system that is commercially available through a vendor.

3.3.3 FIRST-TIER SCREENING OF TECHNOLOGIES

Using the FOM method, the technologies were compared, assessed and ranked against the evaluation criteria. Additional data, including a summary of functional and operational requirements, were developed as necessary to provide a more thorough evaluation. Each technology was ranked low, medium or high. A corresponding score of one (1) was assigned to a low level of compliance with a given criterion, a score of two (2) was assigned to a medium level of compliance and a score of three (3) was assigned to a high level of compliance.

The technologies were then ranked based on the total score for each technology. The seven (7) technologies with the highest total scores were selected for further consideration.

A description of the selected technologies is presented below. Conceptual flowcharts are attached as **Figures 3-2 through 3-8**. Additional information on each of the technologies may be found in the Appendix-Vendor and Technology Information, April 2000.

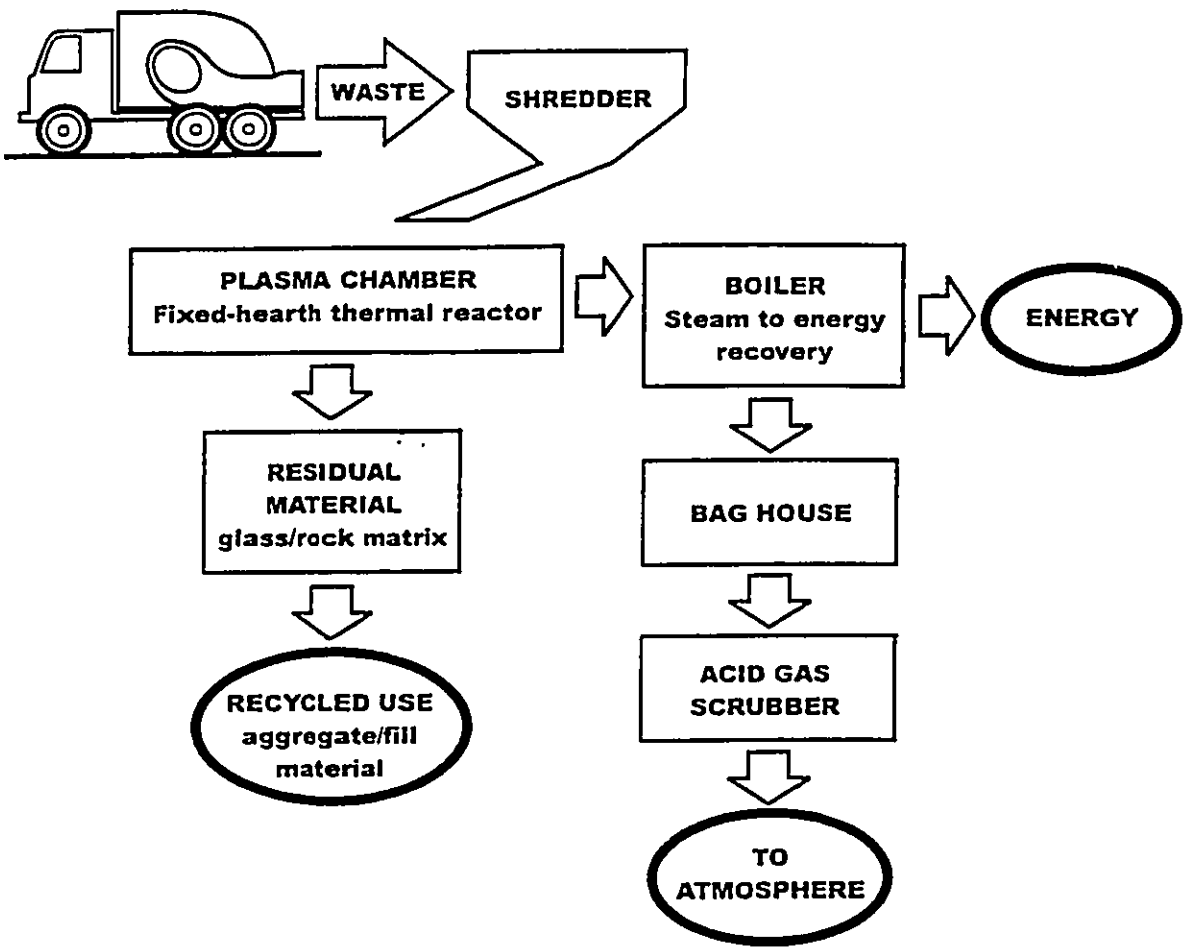


FIGURE 3-2
Alt. 1 - Plasma Oxidation/ Vitrification

Alternatives Analysis for Disposal of Municipal Solid Waste (MSW)

Dept. Of Environmental Services (ENV) - C & C Honolulu
Waste Management of Hawaii, Inc.

R. M. TOWILL CORPORATION

Source: *New Systems Research for Refuse Disposal,* C & C Honolulu, ENV, April 2000

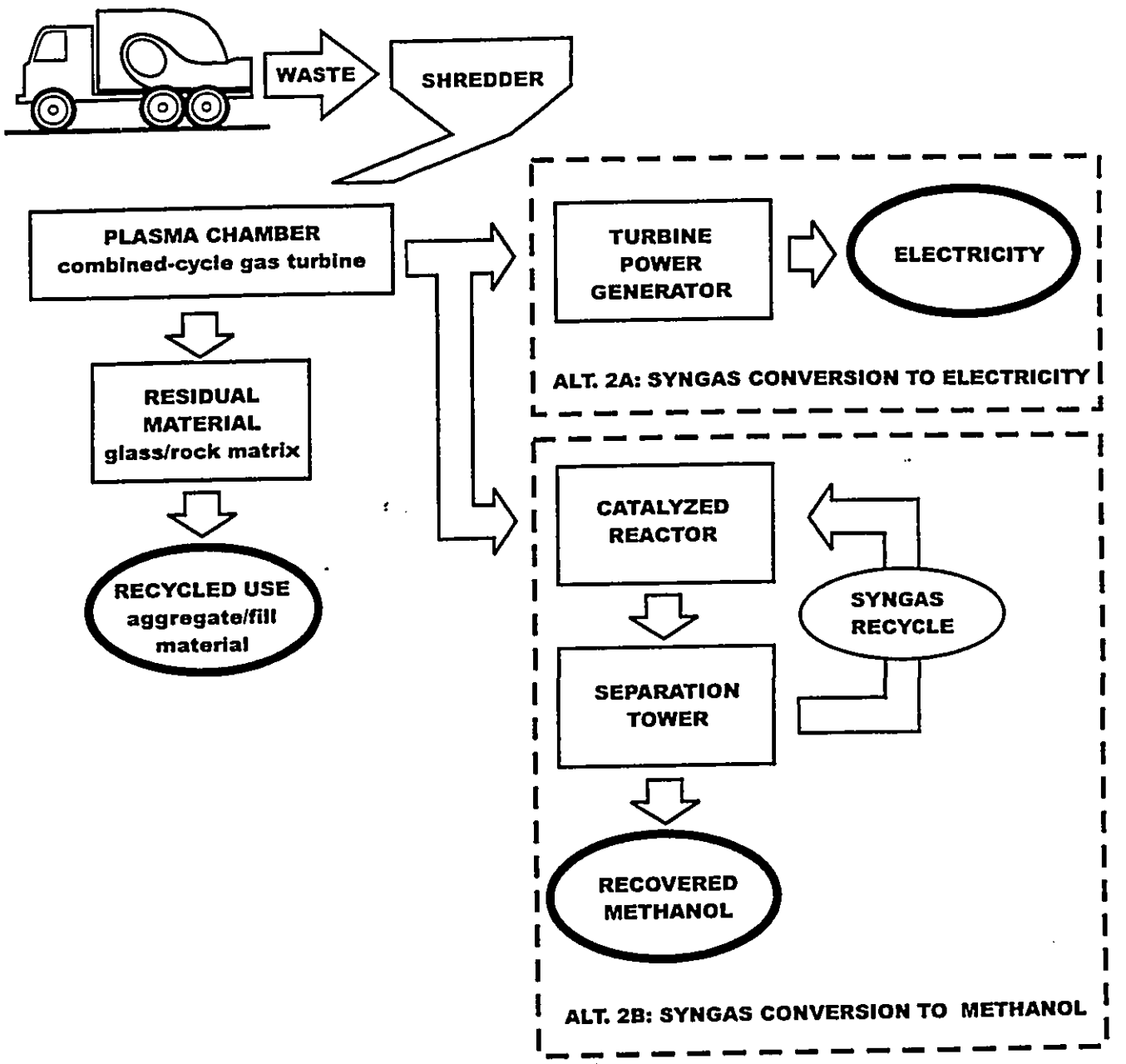


FIGURE 3-3
Alt. 2 - Plasma Gasification/ Vitrification

Alternatives Analysis for Disposal of Municipal Solid Waste (MSW)

Dept. Of Environmental Services (ENV) • C & C Honolulu
Waste Management of Hawaii, Inc.

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Source: *New Systems Research for Refuse Disposal,* C & C Honolulu, ENV, April 2000

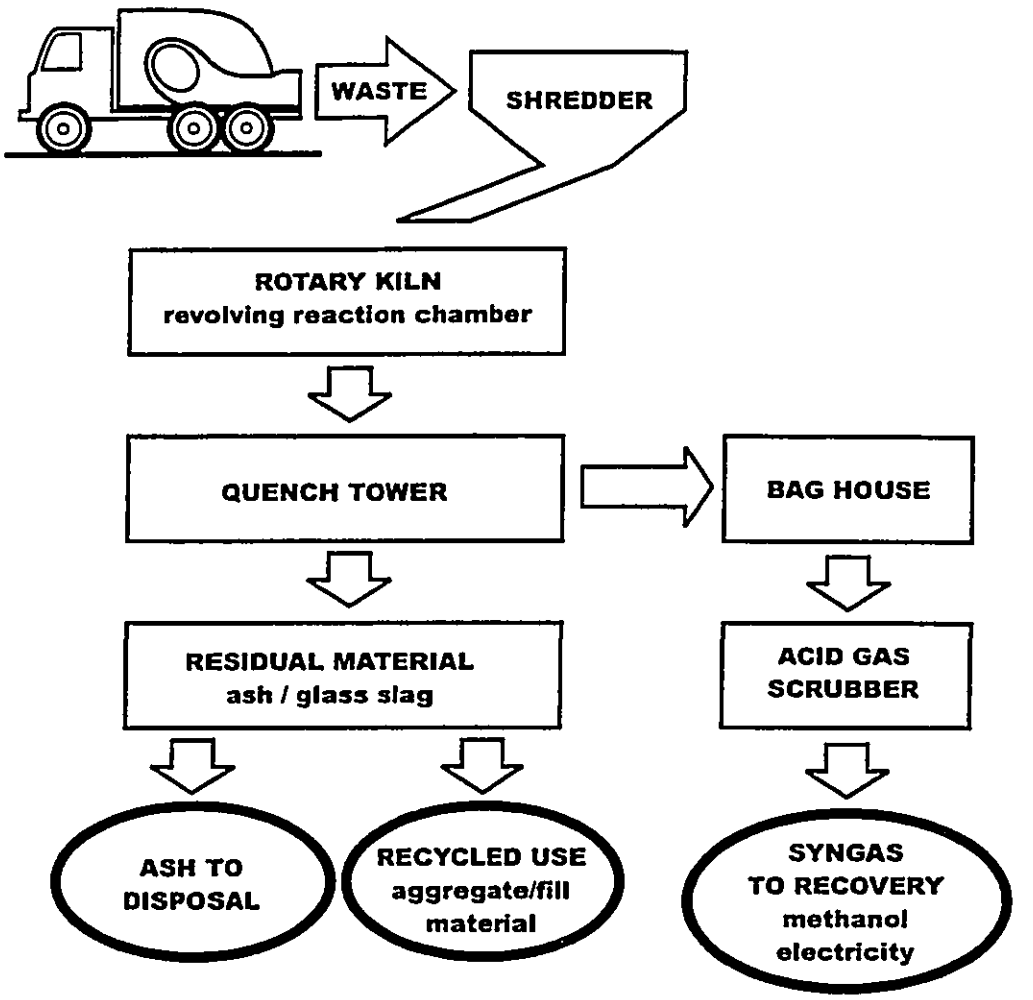

FIGURE 3-4
Alt. 3 - Rotary Kiln Gasification Slagging and Methanol Recovery

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Source: *New Systems Research for Refuse Disposal,* C & C Honolulu, ENV, April 2000

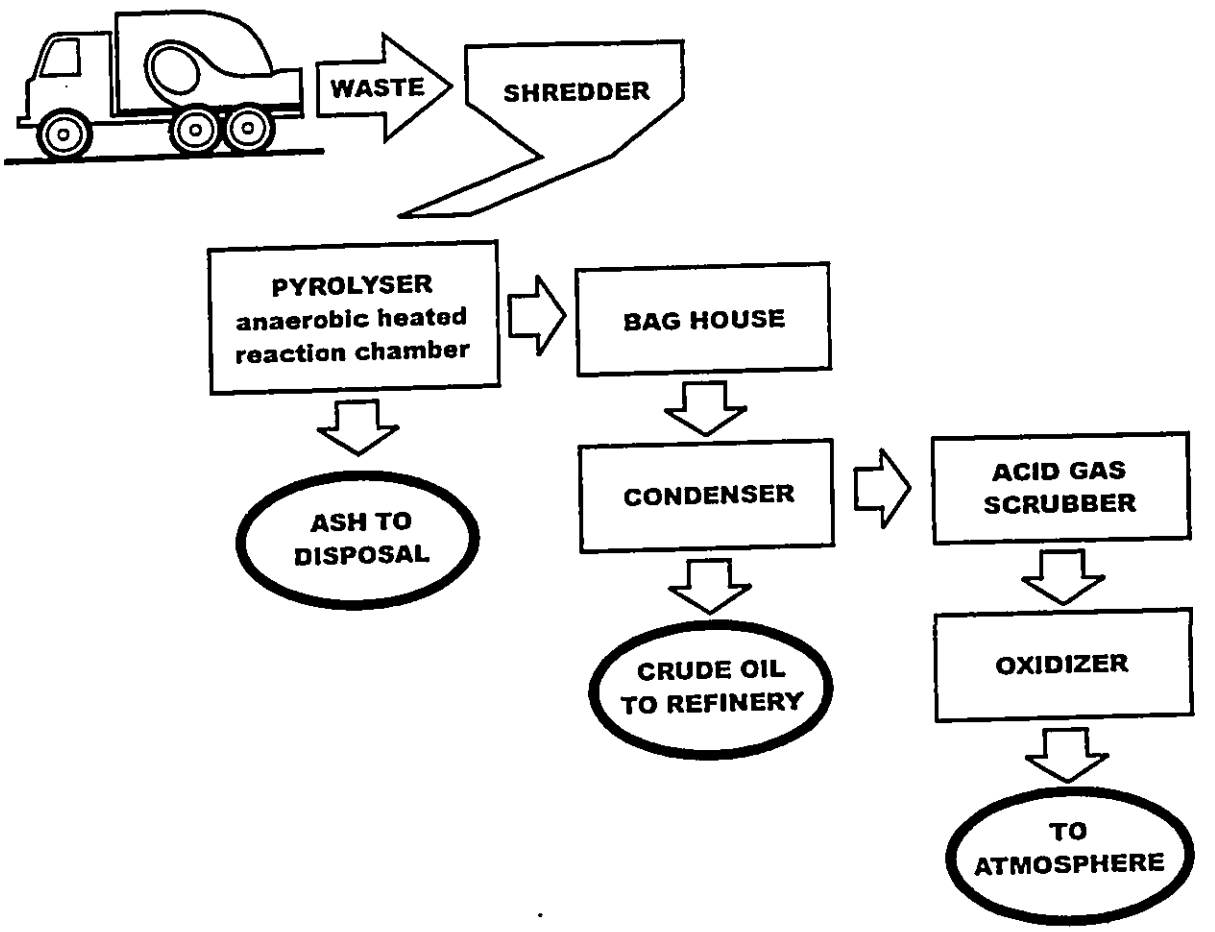


FIGURE 3-5
Alt. 4 - Low - Temp
Pyrolysis/Oil Recovery

Alternatives Analysis for Disposal of
Municipal Solid Waste (MSW)

Dept. Of Environmental Services (ENV) • C & C Honolulu
Waste Management of Hawaii, Inc.

R.M. TOWILL CORPORATION

Source: *New Systems Research for Refuse Disposal.*
C & C Honolulu, ENV, April 2000

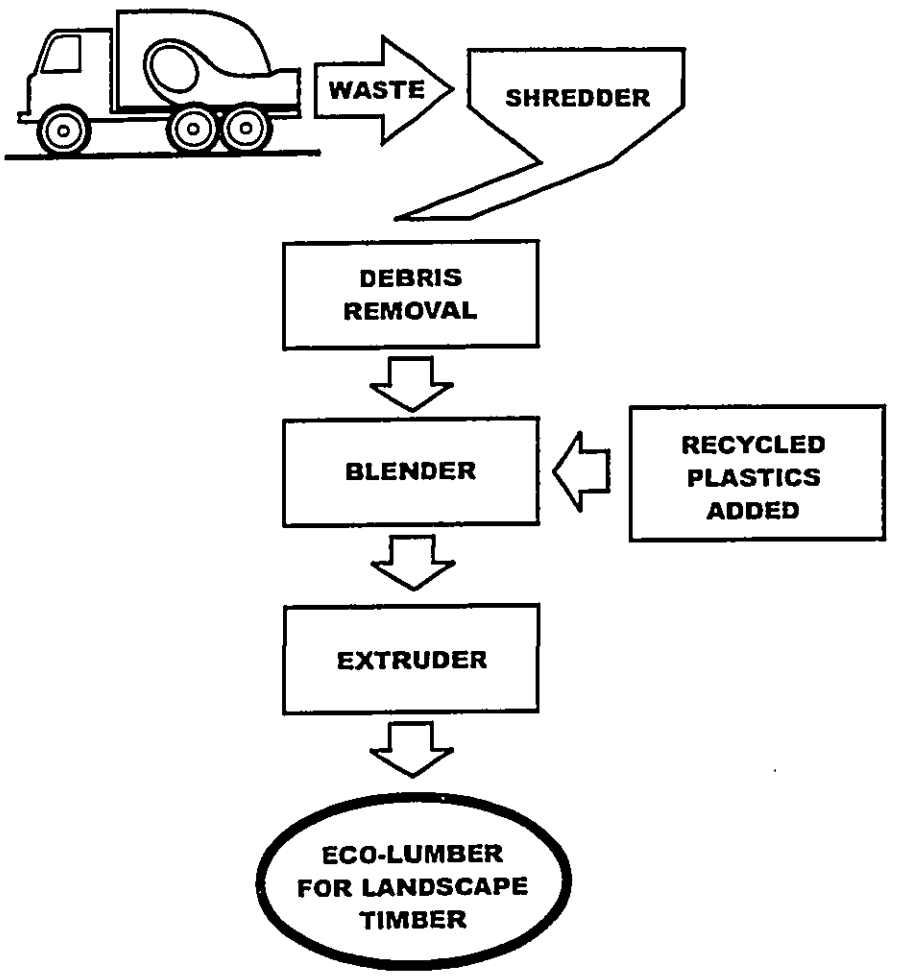


FIGURE 3-6
Alt. 5 - Conversion of Wood/Plastic Wastes to Eco-Lumber

Alternatives Analysis for Disposal of Municipal Solid Waste (MSW)
Dept. Of Environmental Services (ENV) • C & C Honolulu
Waste Management of Hawaii, Inc.

R.M. TOWILL CORPORATION

Source: *New Systems Research for Refuse Disposal,* C & C Honolulu, ENV, April 2000

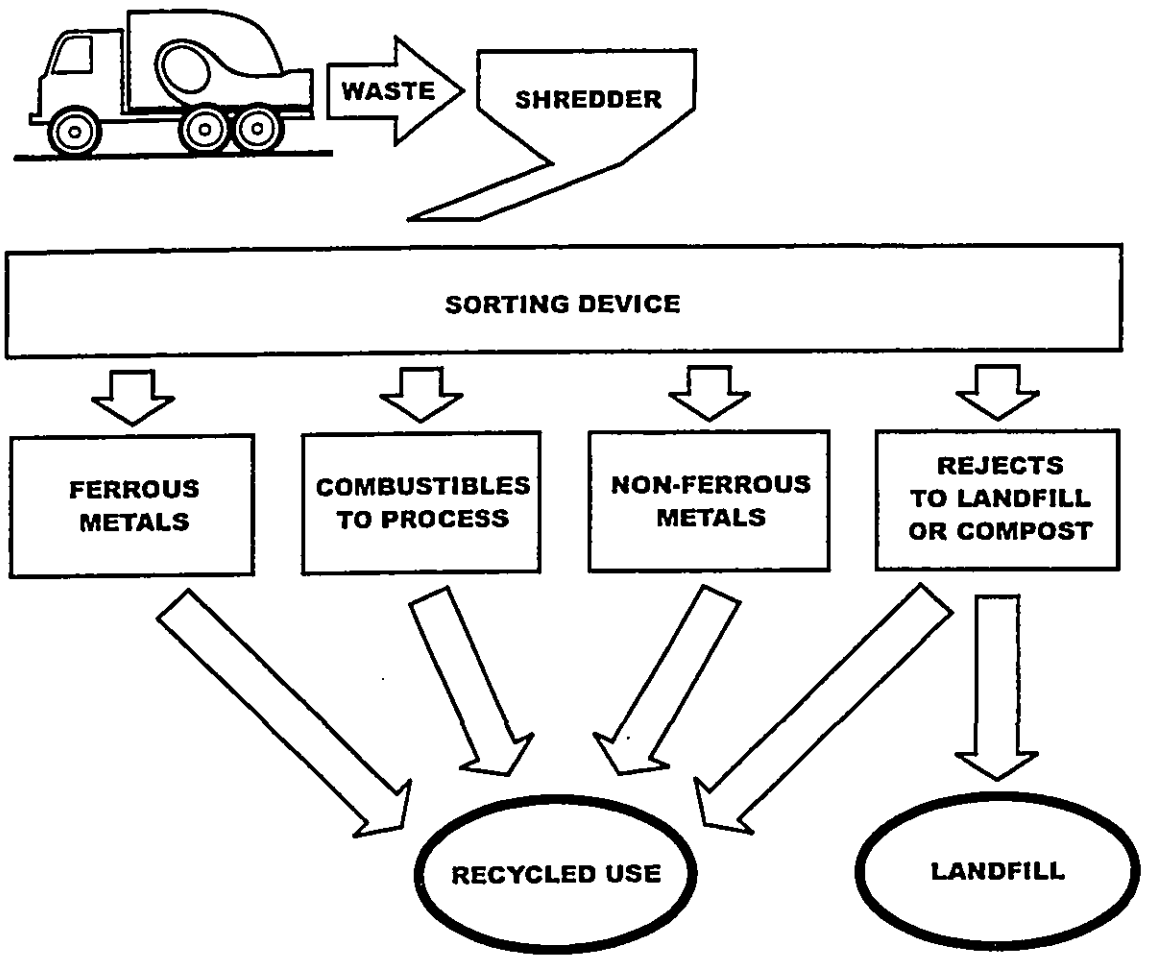


FIGURE 3-7
Alt. 6 - Metals Recovery

Alternatives Analysis for Disposal of Municipal Solid Waste (MSW)

Dept. Of Environmental Services (ENV) • C & C Honolulu
Waste Management of Hawaii, Inc.

R. M. TOWILL CORPORATION

Source: *New Systems Research for Refuse Disposal,* C & C Honolulu, ENV, April 2000

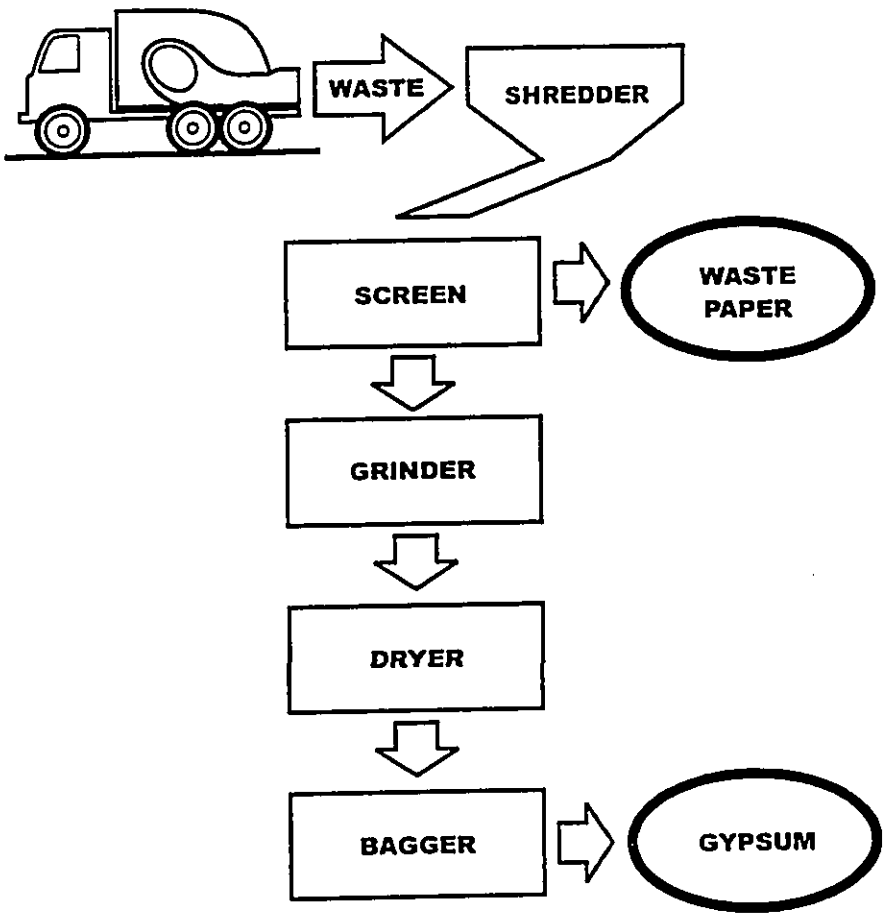


FIGURE 3-8
Alt. 7 - Gypsum Recovery from Wallboard

Alternatives Analysis for Disposal of Municipal Solid Waste (MSW)
Dept. Of Environmental Services (ENV) • C & C Honolulu
Waste Management of Hawaii, Inc.

R.M. TOWILL CORPORATION

Source: *New Systems Research for Refuse Disposal.* C & C Honolulu, ENV, April 2000

The seven technologies can be used in numerous system variations. System variations development for the alternative technology analysis involved the following:

3.3.3.1 ALTERNATIVE 1 - PLASMA OXIDATION/VITRIFICATION FOLLOWED BY CONVERSION OF HEAT TO ELECTRICITY IN A BOILER

Alternative 1 uses thermal oxidation of waste materials in plasma and joule heated process chambers. The combined electrical heating destroys all of the organic compounds contained in the refuse and vitrifies the inert material into a glass or rock-like matrix. The thermal reactor is stationary (fixed-hearth), uses conventional technologies and accessories and can process a wide variety of materials to produce a totally inert residue that can be beneficially employed as an aggregate or filler. A steam boiler is included for energy recovery.

Advantages include a relatively simple operation, proven technology, multiple supplier sources, waste-heat and product recovery in the form of a glass-like material. Disadvantages are low thermal efficiency and potential high risk in permitting.

3.3.3.2 ALTERNATIVE 2 - PLASMA GASIFICATION/VITRIFICATION

Alternative 2 uses thermal gasification/vitrification of refuse materials in plasma and joule heated process chambers. A series of high-temperature plasma torches are used to decompose all organic components and melt inorganic residues into a rock-like glass material. It employs a combined-cycle gas turbine to generate power from the synthesis gas formed by the gasification of organic materials. Plasma temperatures reach 3,000-5,000° F, so most organic compounds break down into elemental components. Any water present reacts with elemental carbon to form carbon monoxide, resulting in a synthesis gas (syngas) that is primarily composed of hydrogen and carbon monoxide.

Alternative 2 can be implemented by using many different energy recovery methods. Two different methods, designated as Alternatives 2A and 2B are described below:

ALTERNATIVE 2A - SYNGAS CONVERSION TO ELECTRICITY IN A TURBINE GENERATOR. This alternative uses syngas to fuel a turbine power generator. A combined-cycle gas turbine generator is reputed to have as much as twice the energy efficiency of typical waste-to-energy thermal boilers.

Advantages of this approach include size efficiency, energy recovery efficiency and revenue from the sale of electricity. A disadvantage is that this technology is relatively immature.

ALTERNATIVE 2B - SYNGAS CONVERSION TO METHANOL. This alternative uses syngas to produce methanol. Methanol is easily produced from syngas in a high-pressure catalyzed reactor. It is a potentially useful transportation fuel, possibly more of a benefit to the Islands than production of electricity.

Advantages of Alternative 2B are the same as for Alternative 2A, except that there may be an advantage to producing transportation fuel that *is now being imported* at a high price. A major disadvantage is higher capital costs than Alternative 2A.

3.3.3.3 ALTERNATIVE 3 - ROTARY KILN GASIFICATION/SLAGGING FOLLOWED BY METHANOL RECOVERY

Alternative 3 uses a more conventional process chamber for converting refuse to methanol. Rotary-kiln gasifiers are designed much like cement kilns, consisting of a long, slowly revolving reaction chamber where heat decomposes organics in refuse into syngas. Rotary-kiln gasifiers have a longer history of operation and have been operated in much larger sizes than plasma vitrification units. Operating temperature is about 2,000°F, compared to approximately 3,000-5,000°F for plasma. Rotary kiln gasifiers can be operated to produce either ash or slag (glass) as the residual. Experience with hazardous waste processing has developed reliable gas-scrubbing systems and cost information in similar-size operations. Like plasma gasifiers, the syngas could be converted to electricity, methanol, or other products.

An advantage is that this technology is more mature than the process used in Alternative 2. Disadvantages are that the unit would use natural gas or oil burners to heat the waste and the operation is anticipated to be more complex.

3.3.3.4 ALTERNATIVE 4 - LOW-TEMPERATURE PYROLYSIS FOLLOWED BY OIL RECOVERY

Low-temperature pyrolysis, also called destructive distillation, operates at lower temperatures than gasification and produces a heavy oil product and a "char" residue that may be burned to heat the reaction chamber. This technology can recover black-carbon. The technology has received significant development during the 1970s as a method for recovering oil from shale deposits. The apparatus is an anaerobic heated reaction chamber, usually a batch reactor, and a condenser to recover the oil. Gas phase byproducts are usually fired in the reactor-heating unit.

Advantages are that capital and operating costs are projected to be lower than for gasification and that the technology is highly regarded by the environmental community. Pilot-scale operations have produced a usable fuel oil. There are specific processes developed in Europe for recycling treated wood. Disadvantages include the undeveloped state of technology and the consequent lack of data on performance and cost.

3.3.3.5 ALTERNATIVE 5 - CONVERSION OF WOOD AND PLASTIC WASTE TO ECO-LUMBER

Alternative 5 is a method of grinding waste wood into fibers, blending the fibers with powdered or melted plastic and extruding the mixture as a monolithic composite material. It was included primarily as a low-cost way to process treated wood, but it could also be used as a method of transforming a majority of the waste stream into a useful product. There are commercially available composites of wood fiber and plastic, but so far, none of the identified products uses recycled plastic or post-consumer waste wood (except clean sawdust from milling operations).

Wood, paper and plastic together comprise 54.7% of the City's waste stream (**Table 3-1**), if furniture and carpet are included. The ratio of plastic materials to wood (including paper) is about 1:4, roughly the ratio of plastic to wood in commercial composites. There is little chance of producing a high-quality aesthetic product for home flooring or decorative use from an uncertain and varying feedstock. However, there are possible uses, such as culvert piping, landscape timbers, parking lot dividers and sea wall timbers, that would tolerate greater variation in product characteristics than the "architectural" products that are currently produced.

This alternative is considered a higher risk "development opportunity" rather than a fully commercial opportunity. Although an operation of this size has not been proven, if successful, it has the potential, based on vendors' cost and revenue estimates, to save significantly more dollars per year compared to other options. ROM capital cost and claimed "production" costs for commercial materials are far below other options. Sale of the product is the key to success, and vendors' claims of product value have been greatly discounted due to the decidedly different nature of a product made from variable materials.

Advantages are a projected low cost, use of well-developed commercial process machinery, the ability to recycle treated wood, and a projected valuable product. Disadvantages are the early state of development, uncertainties about the product and lack of operating data.

3.3.3.6 ALTERNATIVE 6 - METALS RECYCLING

The metals recovery and recycling alternative uses magnetic fields and eddy currents to remove metals from a stream of shredded waste that passes by on a belt conveyor or similar device. Typically, magnets recover ferrous metals, and eddy-current devices remove non-ferrous metals.

There are other ways to separate the metals from the waste at the landfill. Loads with large amounts of metal can be tipped in a separate area of the working face and a magnet used to

remove the ferrous metal. After the metal is removed, the waste is covered as usual. This method will not work with non-ferrous metals.

Advantages are a relatively low-cost and low-risk operation that is already in common use in the industry. It addresses a relatively small portion of the waste stream, but at low cost. There is some potential for direct profit from recycled materials. Numerous vendors are available for metal-recovery operations, and most of such operations are profitable. Metals comprise 12.3% of the waste stream and possibly a significant portion of the "furniture/mattresses" stream (5.1%) as well. Metal recovery is beneficial to the other technologies being considered by reducing potential handling difficulties and abrasion, as well as by reducing the volume of the waste stream. A disadvantage is that metals recovery addresses only a small portion of the waste stream and therefore diverts little from the landfill.

3.3.3.7 ALTERNATIVE 7 - GYPSUM RECYCLING

Recovering gypsum from wallboard is simple and represents approximately 7% of the volume of the refuse stream being sent to the Waimanalo Gulch Sanitary Landfill. Some of the gypsum waste identified as being disposed at Waimanalo Gulch is mixed with other materials and some is painted or wall papered. If mixed with other materials, it may not be useable. If coated with paint or wallpaper, it may also not be useable due to the difficulty of removing the coatings.

Gypsum is widely used as a soil amendment, and the projected volume of 15,000 tons per year would justify a dedicated operation, either by a contractor or directly by the City. Gypsum is recovered by grinding the wallboard, often in two stages, removing any metals, screening out the paper, and drying and bagging the gypsum powder. Advantages are low cost, use of a proven technology, and simple operation. A disadvantage is that gypsum recovery addresses only a small portion of the waste stream.

3.3.4 TECHNICAL DISCUSSION

The following provides a summary discussion of issues that were considered in the technology selection process.

3.3.4.1 SORTING

The review found that the level of sorting required before processing is an important consideration in the system complexities and the capital and operating costs. The technologies identified all require some level of sorting. Alternatives 1, 2 and 3 include removing metals through an automated sorting process, consisting of shredding and magnetic removal of ferrous metals. Additional sorting, such as removing and recycling wallboard, would be helpful and probably cost effective.

Alternative 4-Low Temperature Pyrolysis Followed by Oil Recovery, benefits strongly from removal of additional inorganic materials besides the metals and wallboard since the "char" left after distilling the organic liquids will be fuel for heating the reactor. This is likely to require hand-sorting.

Alternative 5-Conversion of Wood and Plastic Waste to Eco-lumber, is likely to require additional sorting to improve the uniformity of the "product." Washing of plastics might be required, and treated wood may need to be processed separately from untreated wood. Provision would need to be made for the removal (or "backhaul") of materials judged to be unsuitable for inclusion in the "product."

3.3.4.2 TREATED WOOD

One of the most "problematic" materials is treated wood refuse. This waste contains potentially toxic materials that limit options for diversion or volume reduction. Hence, any thermal technology employed to process the wood must contend with toxic metals emissions. The plasma gasification/vitrification technology offers the most advantageous solution in dealing with the toxic contamination in the treated wood stream. This advantage stems from

three factors: the destruction of organics in wood preservers; the capture of solid phase metals in wood preservers; and, the capture of gaseous phase metals in wood preservers.

3.3.4.3 DIRT AND YARD WASTE

Dirt and yard waste are already addressed by existing composting programs. Dirt, yard, and food waste can be processed by the selected technologies but may be better addressed by composting. Any possible diversion of these materials to existing compost operations is a significant process benefit and probably a cost saving measure. However, separating these materials is expected to be more costly than disposal.

3.3.3.4 FUELS

Alternatives 2 and 3 include a gas production option for applications that can replace oil fuel with synthesis gas. Generating gas instead of electricity significantly lowers the facility cost. Converting the gas to methanol would add to the facility cost but produce a valuable product that could be used to power the City's vehicles, for example. Alternative 5-Conversion of Wood and Plastic Waste to Eco-lumber, includes the selective removal of wood, paper and plastics from the waste stream. The wood, paper and plastics would be processed separately and then blended into an extruded composite, suitable for landscape timbers, parking lot dividers and similar applications. The end product could also be pelletized to form a high BTU/ low ash refuse derived fuel (RDF), but the presence of a significant percentage of treated wood would limit the type of facility that could burn it while controlling metals emissions. Manual sorting could be extended to separate treated from untreated wood, with the treated wood processed separately as landscape material and the untreated wood processed as RDF. The value of RDF would depend on having a suitable use for the fuel, possibly to supplement H-POWER or as a home-heating product. Home wood-burning stoves are more common in colder climates, so the RDF might be an "export" product if shipping costs and production volume are economically viable.

3.3.4.5 ELECTRIC POWER

Alternatives 1, 2, and 3 have the potential to use and/or produce significant amounts of electrical power. A suitable location with full access to the electrical grid has been assumed. If fuels from the processes were to be useful in H-POWER, they would benefit from being located nearby.

3.4 SECOND TIER SCREENING OF ALTERNATIVE TECHNOLOGIES

The purpose of the second-tier screening was to short-list to three, the number of technologies being considered for further evaluation. This section contains a description of this second-tier screening process. **Table 3-2**, provides the results of the second-tier screening process.

3.4.1 SCREENING CRITERIA FOR SHORT-LISTING TECHNOLOGIES

A review of reports from previous studies completed for the City was conducted to develop the second-tier screening criteria. Information was also obtained on the current waste management conditions and requirements on Oahu. The resultant screening criteria included the following:

Waste Stream Application - The waste stream application criterion requires that the selected technology be capable of diverting the waste streams selected for the study. The waste streams selected for inclusion are all wastes that are currently being disposed of at the Waimanalo Gulch Sanitary Landfill. Waste being sent to H-POWER and ash from H-POWER are excluded from consideration. The composition of the Waimanalo Gulch Sanitary Landfill waste (**Table 3-1**) is 31.2 % wood (13.9% treated wood), 8.9% paper, 12.3% metal (6.7% ferrous), 5.0% plastics, 5.1% furniture, 4.5% carpet and 20.0% inorganics (7.0% wallboard). Other listed materials are largely wastes with existing treatment programs, such as composting. This waste composition, particularly the high percentage of treated wood, strongly influenced the selection of technologies due to environmental factors involving removal and/or need for treatment of toxic metals.

TABLE 3-2
Evaluation and Scoring of Technologies

Alternative	Waste Streatm Applica-tion	Volume Reduc-tion	Past Operating Perform-ance	Past Economic Perform-ance	Environ-mental Risk	Total Score
Alternative 1 - Plasma Oxidation / Vitrification	3	2	2	1	1	9
Alternative 2A - Plasma Gasification/Vitrifica-tion /Electricity	3	3	1	1	3	11
Alternative 2B - Plasma Gasification/Vitrifica-tion/Methanol	3	3	1	1	2	10
Alternative 3 - Rot. Kiln Gasification/Slagging / Methanol	3	3	1	1	2	10
Alternative 4 - Low Temp. Pyrolysis	2	2	1	1	2	8
Alternative 5 -Wood /Plastic to Eco-lumber	1	3	1	1	3	9
Alternative 6 - Metals Recycling	2	3	3	2	3	13
Alternative 7 - Gypsum Recycling	2	3	3	2	3	13

Scores:
1 = Low level of compliance with evaluation criteria.
2 = Medium level of compliance with evaluation criteria.
3 = High level of compliance with evaluation criteria.

Volume Reduction (VR) Performance - The volume reduction performance screening criterion requires that the selected technology provide capability for diverting or reducing the volume requiring disposal for a major portion of the waste stream.

Past Operating Performance - The proven past operating performance screening criterion requires that the selected technology have a successful operating record in a municipality that has a similar material processing need as the City. It may be innovative but not experimental.

Past Economic Performance - The proven past economic performance screening criterion requires that the selected technology should be cost effective when compared to the City's existing landfill costs.

Environmental Risk - The environmental risk screening criterion requires that the selected technology be "Environmentally Friendly," that is, not damage or degrade the environment, and be "Island Friendly," readily adapted to the climate, geography, economy, culture and lifestyle of Oahu. The technology must be readily permitted, involving no difficult regulatory hurdles or delays.

3.4.2 RANKING THE SEVEN TECHNOLOGY ALTERNATIVES

The seven technologies were evaluated against each of the criteria and were scored as low, medium or high. A score of one (1) was assigned to a low level of compliance; a score of two (2) was assigned to a medium level of compliance, and a score of three (3) was assigned to a high level of compliance.

The technologies were ranked based on the total score for each. Technologies with the highest composite score meeting the selection criteria were selected for further final evaluation.

The seven technologies were reviewed in light of the screening criteria and scored each technology on its advantages and disadvantages relative to each criterion.

3.4.3 TECHNOLOGY ALTERNATIVES REJECTED

Alternatives 1, 2B, 3, 4 and 5 were not short-listed for further evaluation. The evaluation indicated that although the technologies were not short-listed, that they may be worthy of further consideration for future application:

Alternative 1 - Plasma Oxidation/Vitrification Followed by Conversion of Heat to Electricity in a Boiler. This alternative was not short-listed because it uses an oxidation process. Oxidation processes would have a large gaseous waste stream and would need state-of-the-art and expensive air pollution control systems to eliminate the reformation of toxic organic gases (such as dioxins and furans) in the gaseous waste stream. Energy recovery in an oxidation system must also be accomplished in steam boilers that have very low heat-to-electricity conversion efficiency.

Alternative 2B - Plasma Gasification Followed by Syngas Conversion to Methanol. This alternative was not short-listed for further evaluation because, while converting syngas to methanol is a common process in refinery plants, it is a novice application in a refuse management system with currently unproven economics.

Alternative 3 - Rotary Kiln Gasification/Slagging Followed by Syngas Conversion to Methanol. This alternative was not short-listed for further evaluation because it would require the use of natural gas or oil for converting refuse to syngas. Also, converting syngas to methanol is a novice application in a refuse management system with currently unproven economics.

Alternative 4 - Low Temperature Pyrolysis and Conversion of Refuse to Oil. This alternative was not short-listed for further evaluation because it does not meet the past

performance criterion and its technical, environmental and economic risks are unknown at this time.

Alternative 5 - Conversion of Wood and Plastic Waste to ECO-Lumber. This alternative was not short-listed for the following key reasons: 1) extensive front-end sorting of refuse would make the operation impractical and costly; 2) liabilities associated with converting a preservative-containing wood waste to a useful product is unknown; 3) the size of the market for selling eco-lumber is unknown; and 4) the technical, environmental and economic risks are currently unknown.

3.4.4 SHORT LISTED TECHNOLOGY ALTERNATIVES

The following alternatives received the highest scores and were recommended for further evaluation:

Alternative 2A - Plasma Gasification/Vitrification Followed by Converting Syngas to Electricity. Alternative A uses a series of high-temperature plasma torches to decompose all organic components of the bulk waste stream and to melt inorganic residues into a glass-like slag. This alternative was ranked in the top three because of several advantages, including environmentally safe treatment of preservative contaminated wood wastes, environmental friendliness, production of needed electricity for the region, and significant reduction in the City's landfill space requirements

Alternative 6 - Metal Recycling. The metals recovery and recycling alternative uses magnetic fields and eddy currents to remove metals from a stream of shredded waste that passes by on a belt conveyor or similar device. Typically, magnets recover ferrous metals and eddy-current devices remove non-ferrous metals. This alternative was short-listed for further evaluation because ferrous metal recovery is a proven recycling method and there is no need for further research and development of this technology.

The City is already practicing metal recovery at H-POWER and a metal recycling application to the Waimanalo Gulch Sanitary Landfill refuse stream could also be implemented without major difficulty.

Alternative 7 - Gypsum Recycling. The scrap gypsum wallboard recycling technology was short-listed for further evaluation because the technology is a proven recycling method and there is a likely market for its product in Hawaii.

3.5 FACILITY CONCEPTS FOR ALTERNATIVE TECHNOLOGIES

3.5.1 INTRODUCTION

Preconceptual designs for each of the three short-listed technologies were developed to provide for more detailed evaluation. Each of the designs were developed to include ancillary systems necessary to implement each of the three technologies. The three integrated facilities include:

- Plasma Generating Station (based on Alternative 1 - Plasm Oxidation/ Vitrification Followed by Conversion of Heat to Electricity in a Boiler)
- Metal Recycling Plant (based on Alternative 6 - Metal Recycling)
- Gypsum Recycling Plant (based on Alternative 7 - Gypsum Recycling)

The integrated facilities preconceptual design includes a block diagram, a facility functional block flow diagram and a facility plot plan. The preconceptual characterization of the options also identifies the functional, operational and performance aspects of the overall system and the key unit operations.

3.5.2 PLASMA GENERATING STATION

The integration of a plasma generating facility into the existing City refuse management system is shown on **Figure 3-9**. **Figure 3-10** shows a functional flow diagram for the station. **Figure 3-11** shows a footprint of the major unit operations and overall land requirements.

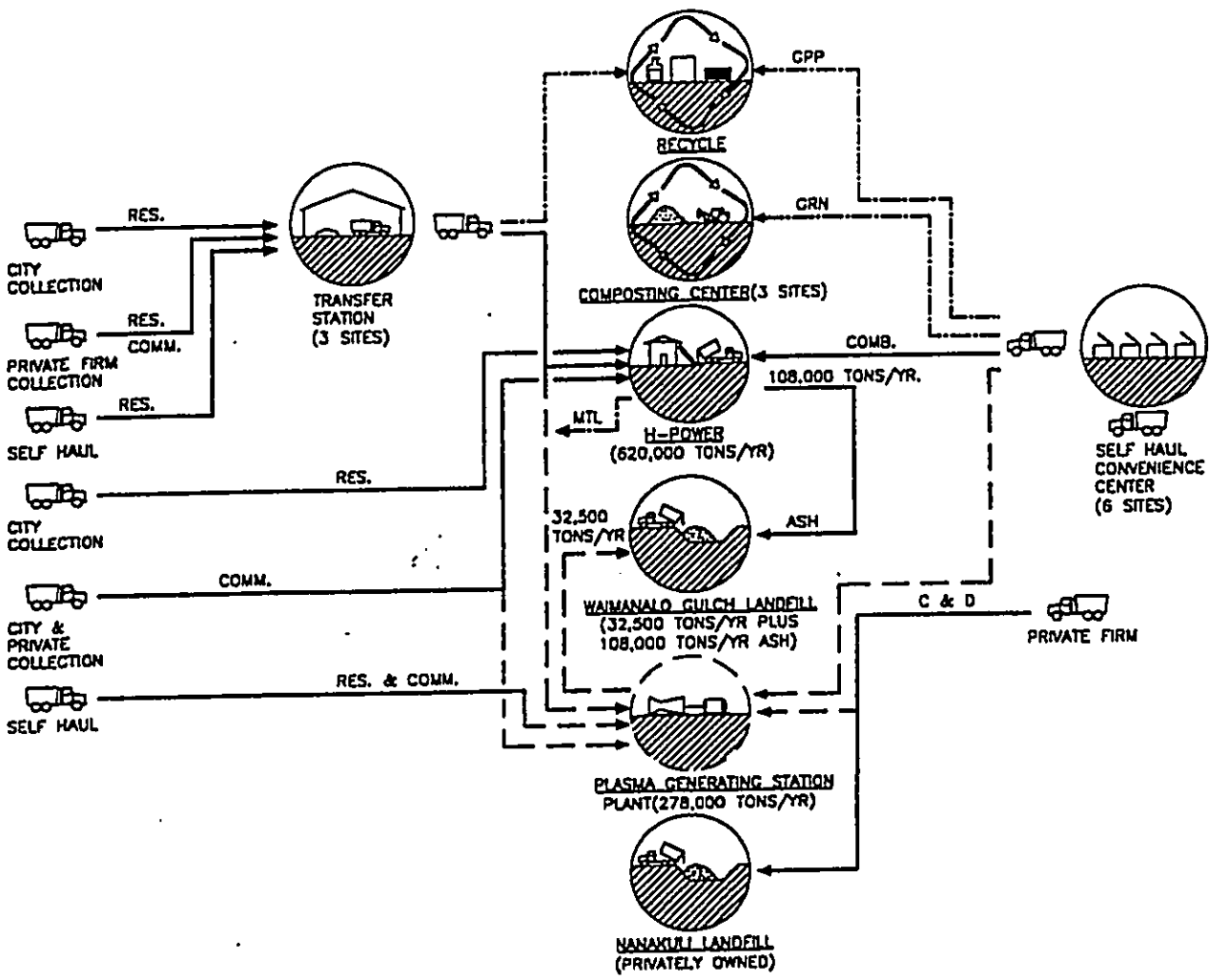
3.5.2.1 FACILITY DESCRIPTION

The Plasma Generating Station will use a plasma gasification and vitrification system and other ancillary equipment to convert the incoming trash into electricity, which can be fed to the Hawaiian Electric Company (HECO) for distribution.

The station will require an approximately 15-acre site and will have an incoming truck receiving, staging and dumping area. An area in the station will be provided for accumulating the incoming waste as needed for surge storage.

As shown in **Figure 3-9**, almost all of the City, private firm and self-hauling refuse trucks going to the Waimanalo Gulch Sanitary Landfill will be diverted to the Plasma Generating Station. Construction and demolition waste haulers will be encouraged to segregate wood-containing debris waste at its source and transport it directly to the Plasma Generating Station.

The material in the incoming waste storage pile will be transferred to a sorting unit. The sorting unit considered in this study is based on an integrated system being marketed by Lube-USA. The unit will have capability to segregate the waste into three categories: combustible, metals and non-recyclable refuse. The sorting unit will transfer each of the three refuse streams to a storage pile. These include storage piles for the refuse to be fed to the plasma unit, metal recycling and the non-recyclable material that must be shipped offsite.



LEGEND
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COMM. = COMMERCIAL WASTE
GRN. = GREEN WASTE
GPP. = GLASS, PAPER, PLASTIC
NON-COMB. = NON-COMBUSTIBLE WASTE
COMB. = COMBUSTIBLE WASTE
C & D = CONSTRUCTION & DEMOLITION
MTL. = METAL RECYCLE
——— EXISTING DISPOSAL FLOW
—·—·— EXISTING RECYCLE FLOW
— — — FLOW PATH FOR NEW PLASMA GENERATION PLANT

FIGURE 3-9
Block Diagram for Integrating Plasma Generating Station into Existing System

Alternatives Analysis for Disposal of Municipal Solid Waste (MSW)
Dept. Of Environmental Services (ENV) • C & C Honolulu
Waste Management of Hawaii, Inc.

R. M. TOWILL CORPORATION

Source: *New Systems Research for Refuse Disposal*, C & C Honolulu, ENV, April 2000

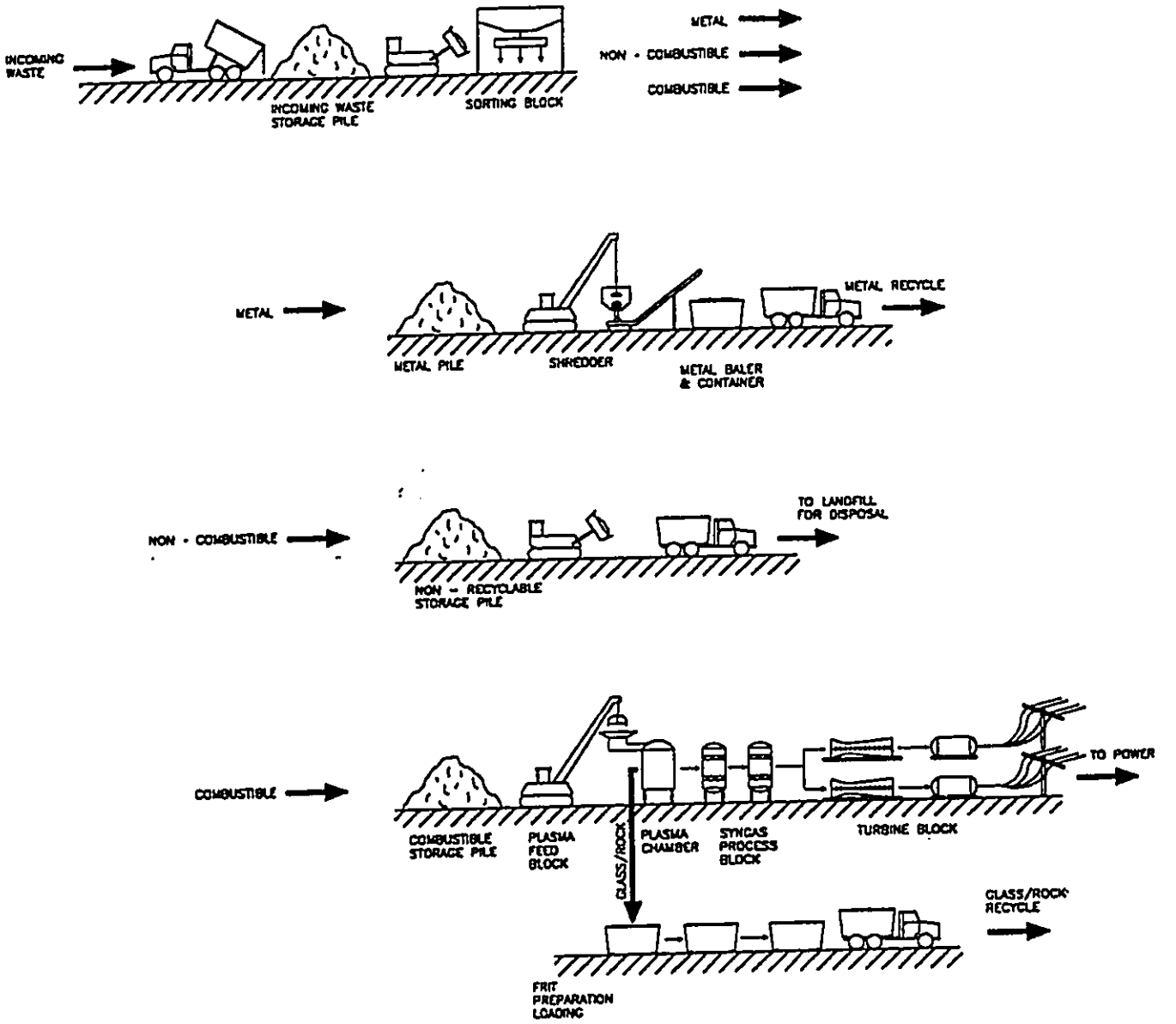


FIGURE 3-10
Block Diagram for
Plasma Generating Station

Alternatives Analysis for Disposal of Municipal Solid Waste (MSW)

Dept. Of Environmental Services (ENV) • C & C Honolulu
Waste Management of Hawaii, Inc.

R.M. TOWILL CORPORATION

Source: *New Systems Research for Refuse Disposal,* C & C Honolulu, ENV, April 2000

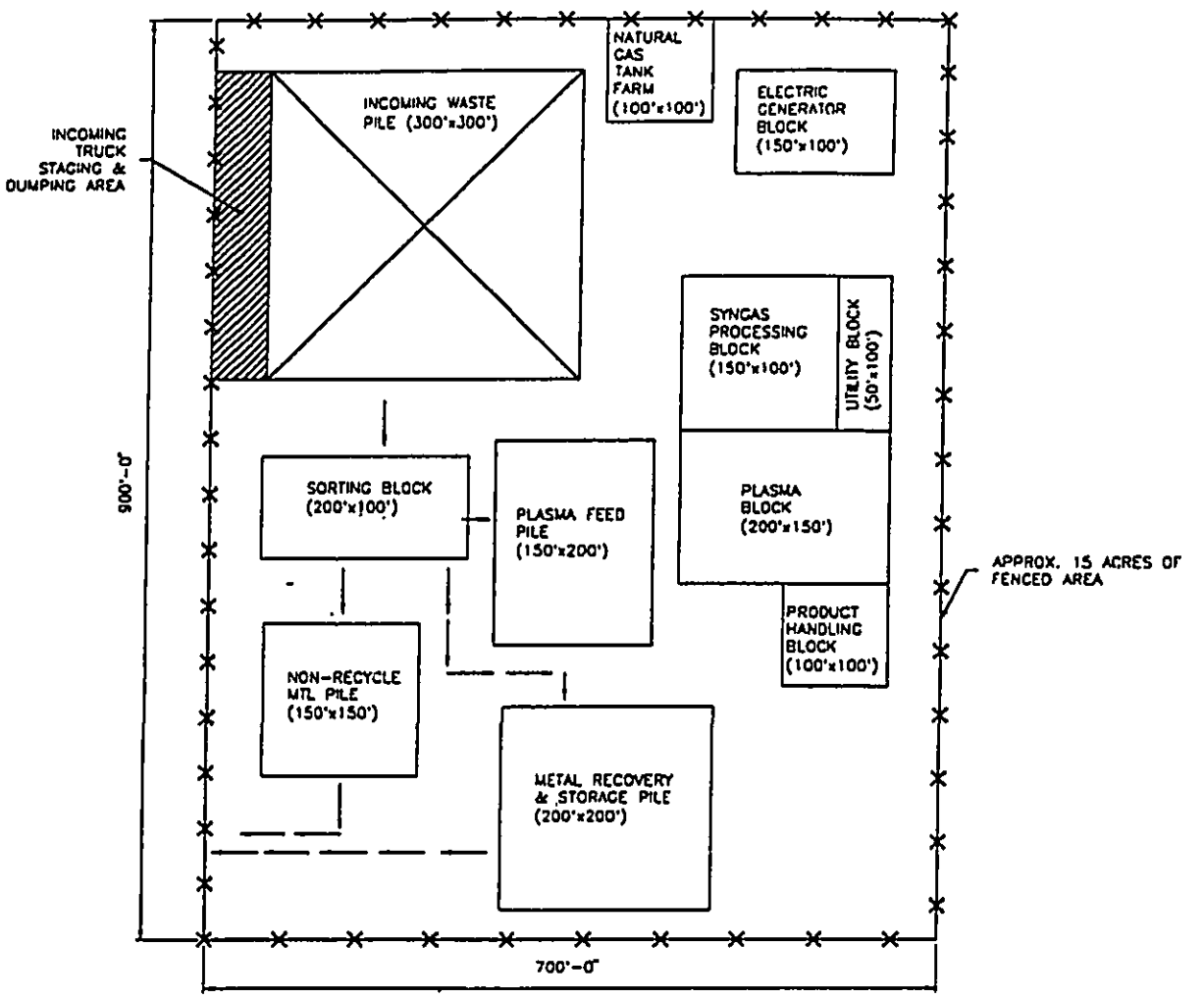


FIGURE 3-11
Land Size Requirements for Plasma Generating Station

Alternatives Analysis for Disposal of Municipal Solid Waste (MSW)
Dept. Of Environmental Services (ENV) • C & C Honolulu
Waste Management of Hawaii, Inc.

R. M. TOWILL CORPORATION

Source: *New Systems Research for Refuse Disposal.*
C & C Honolulu, ENV, April 2000

The plasma unit considered in this study is based on the technology being marketed by Integrated Environmental Technology (IET) of Richland, Washington. The unit will have a feed system that will prepare and feed the incoming refuse to the plasma chamber. The IET plasma chamber will have both a direct current (DC) plasma arc system and a Joule heating system. The plasma chamber will be designed for operation in a gasification mode. A treatment train will be provided to treat the gaseous product to produce a synthesis gas (or syngas). The inert product, a glass-like material will be converted into re-usable material by a product handling subsystem.

A set of turbine generators, including all of the associated electrical and mechanical support units, will be provided to convert the plasma system syngas into electricity. The gas turbine considered in this study is based on industrial gas turbine technology being marketed by TUMA Turbinematch, SA, of Switzerland. The turbine block will also have a natural gas tank farm. The turbine will use natural gas during the station start-up, maintenance down times, and idle periods. During normal operation, it is anticipated that approximately 60% to 80% of the electricity will be used internally. The remaining power produced by the station will be sold.

The sorting system at the Plasma Generating Station will be upgraded to include metal recovery, since this feature can be added with only minor capital cost. The metal sorting part of the station will include magnetic separation devices at the sorting station, bulk size reduction units, and metal shredding units. The station will consist of the following units/operations:

Incoming Truck Staging & Dumping
Sorting
Metal Recycling
Non-Recyclable Waste Loading
Plasma Feeder
Plasma Chamber

Syngas Processing Unit

Turbine Generator

Natural Gas Tank Farm

Product Handling

3.5.2.2 FUNCTIONAL AND OPERATIONAL REQUIREMENTS

The facility is proposed to meet the following functional and operational requirements:

Function - The Plasma Generating Station will receive, sort and process for recycling and energy recovery in the form of electrical power, a major portion of the City refuse that is currently being sent to Waimanalo Gulch Sanitary Landfill. The station will segregate combustible material and metals from the incoming wastes and return any non-combustible refuse to Waimanalo Gulch for landfill disposal. Metals will be size-reduced and packaged in containers ready for shipment to offshore recycling steel mills. The station will use the segregated combustible refuse as a feedstock to the plasma gasification/vitrification system. This plasma system will convert the organic content of the feedstock into a synthesis gas, which will be cleaned and used in a turbine generator to produce electricity. The inert material, including metals, contained in the station will be converted into a material that is recyclable.

Operations - Almost all of the refuse trucks currently transporting refuse to Waimanalo Gulch will be diverted to the Plasma Generating Station. It is estimated that the refuse received by the Plasma Generating Station will be approximately 278,000 tons per year. The plasma system will process approximately 70% (or 195,000 tons per year) of the incoming refuse. The composition of this waste is anticipated to be as follows: 8.9% paper + 5% plastic + 31.2% wood + 16% furniture and carpet + 10% inorganic composite = 70%.

It is estimated the remaining 30% (or 30% X 278,000 tons/yr = 83,000 tons/yr) of the incoming refuse will be either scrap metal or a non-combustible material (such as

concrete and soils). The scrap metal can be processed by the metal recycling portion of the station. Non-combustible (such as concrete and soils) are not economical for vitrification and must be sent to the landfill for disposal. The metal recycling portion of the station will recover approximately 90% of the available scrap metal (i.e., 0.9 x 12.3% x 278,000 = 31,000 tons per year from the refuse currently being sent to the Waimanalo Gulch Landfill. The remaining refuse, approximately 52,000 tons/year will be sent to the landfill. Also, it is estimated that approximately 10% of the waste processed by the plasma system (or 70% X 278,000 tons/yr. X 10% = 19,500 tons per year) will be a glass-like material which could possibly be recycled in the future for use as road or construction concrete aggregate. Feasibility for use of this material will depend on chemical constituency and whether there is presence of toxic or hazardous compounds remaining in the material. The station will operate 24 hours per day and 330 days per year. Performance - Metal recovery efficiency will be approximately 90% of the total incoming ferrous metals. Waste segregated for plasma feed operations will have approximately 70% combustible material. The station will be self-powered and will produce approximately 300 kwh of excess power per ton of waste processed by the plasma unit.

Permitting - The station will require a National Pollutant Discharge Elimination System (NPDES) permit for discharges of liquid effluent to State waters. A Clean Air Permit from the State of Hawaii, Department of Health (DOH), will be required for the turbine generator units. Fugitive emissions of dust and other airborne pollutants will be minimized through appropriate design. A DOH, Solid Waste Permit will be required for construction and operation of the facility.

Design, Installation and Construction - The station will be designed, installed and constructed to meet national and local codes and standards. All equipment and systems will be designed for outdoor installation. Equipment will be pre-assembled and tested at the factory to minimize delays due to field start-up problems.

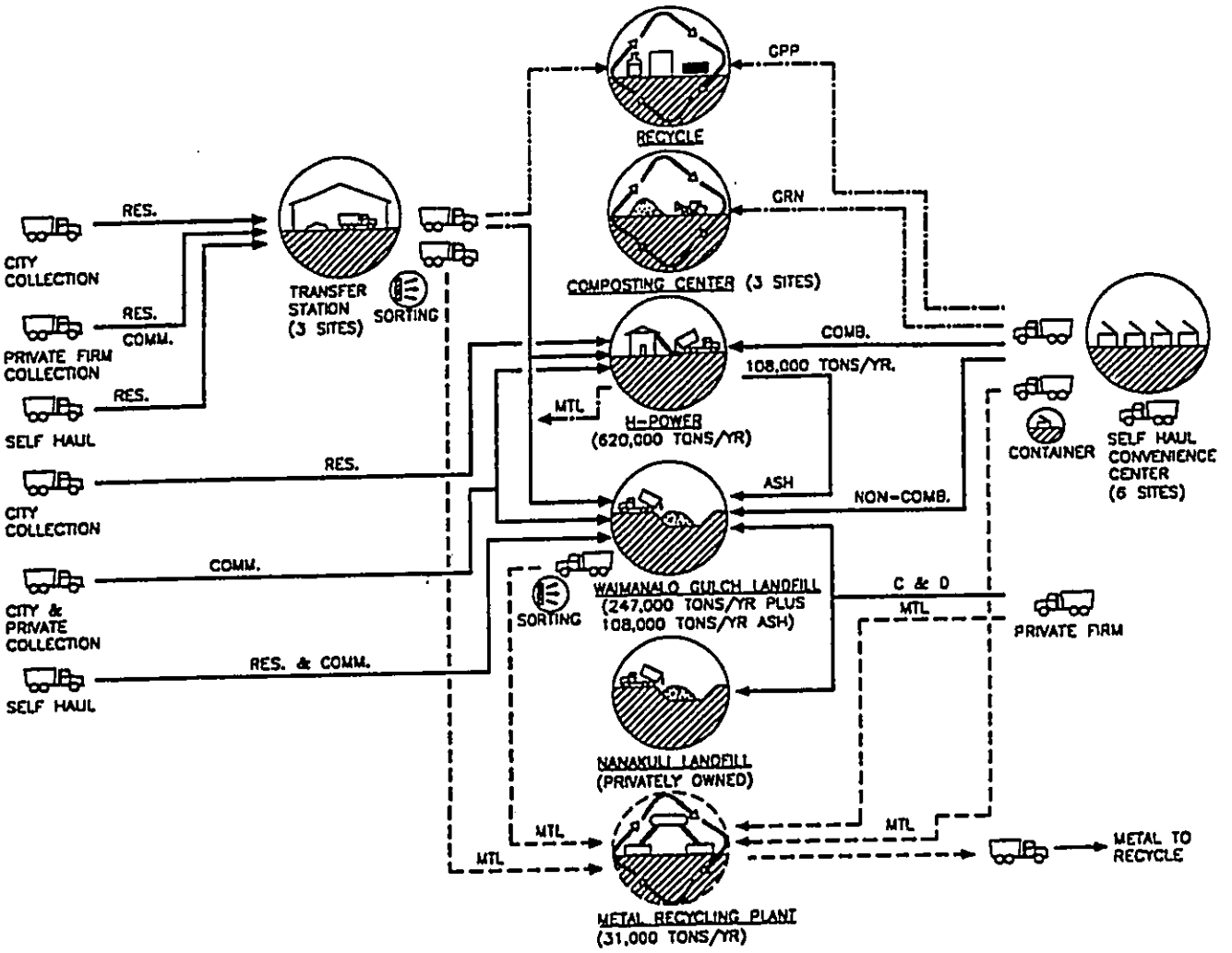
3.5.3 METAL RECYCLING PLANT

The integration of a metal recovery plant into the existing City refuse management system is shown on **Figure 3-12.** **Figure 3-13,** shows a functional flow diagram for the plant. **Figure 3-14,** shows the footprint for the major unit operations and the overall land requirements for the metal recycling plant.

3.5.3.1 FACILITY DESCRIPTION

The metal recycling plant will use sorting and shredding technologies to recover ferrous metals from the incoming refuse. Recovered metals will be sent to existing recycling companies. Special containers (e.g., roll-off bins) for metal recycling will be placed at a sanitary landfill. Operating personnel will remove metal containing objects from the incoming refuse and place them on the recycling containers. Trucks, provided by the metal recycling plant, will transport the containers to the plant. Private construction and demolition waste haulers will be encouraged to segregate metal-containing refuse at its source and transport it directly to the recycling plant. The plant will require an approximately 8-acre site and will have an incoming truck receiving, staging and dumping area. An area in the station will be provided for accumulating the incoming waste as needed for surge storage.

The material in the incoming waste storage pile will be transferred to a sorting unit. The sorting unit considered in this study is based on an integrated system being marketed by Innovative Recycling Systems, Inc., of Solon, Ohio. The unit will have capability to segregate the waste into two categories: metals and non-recyclable refuse. The sorting unit will transfer each of the two refuse streams to a surge storage pile.



LEGEND
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COMB. = COMBUSTIBLE WASTE
C & D = CONSTRUCTION & DEMOLITION
MTL. = METAL RECYCLE
———— EXISTING DISPOSAL FLOW
—·—·—·— EXISTING RECYCLE FLOW
- - - - - - NEW SYSTEM EVALUATION BY NSR STUDY

FIGURE 3-12
Block Diagram for Integrating Metal Recycling Plant into Existing System

Alternatives Analysis for Disposal of Municipal Solid Waste (MSW)
Dept. Of Environmental Services (ENV) • C & C Honolulu
Waste Management of Hawaii, Inc.

R. M. TOWILL CORPORATION

Source: *New Systems Research for Refuse Disposal,* C & C Honolulu, ENV, April 2000

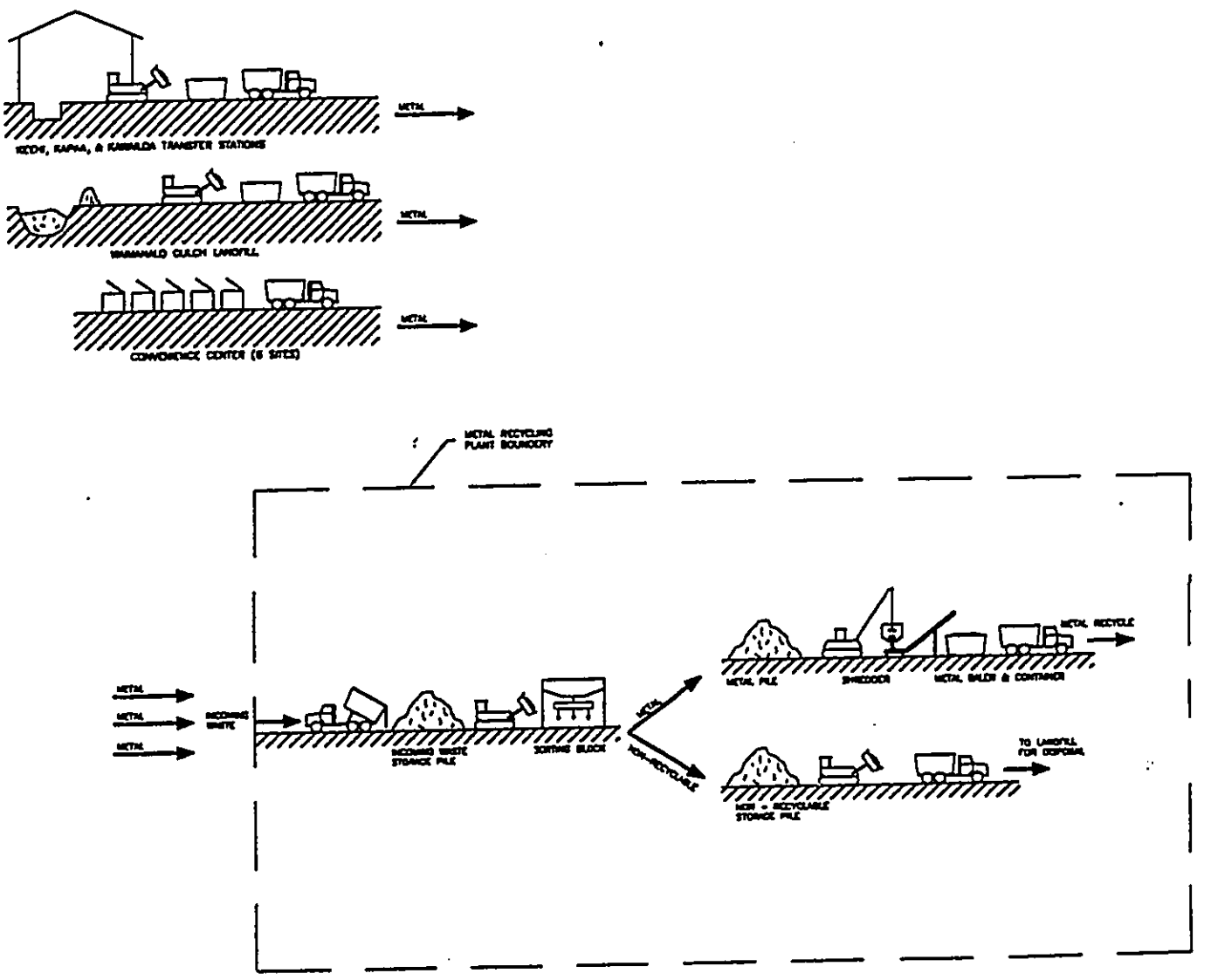


FIGURE 3-13
Block Diagram for Metal Recycling Plant

Alternatives Analysis for Disposal of Municipal Solid Waste (MSW)
Dept. Of Environmental Services (ENV) • C & C Honolulu
Waste Management of Hawaii, Inc.

R.M. TOWILL CORPORATION

Source: *New Systems Research for Refuse Disposal.*
C & C Honolulu, ENV, April 2000

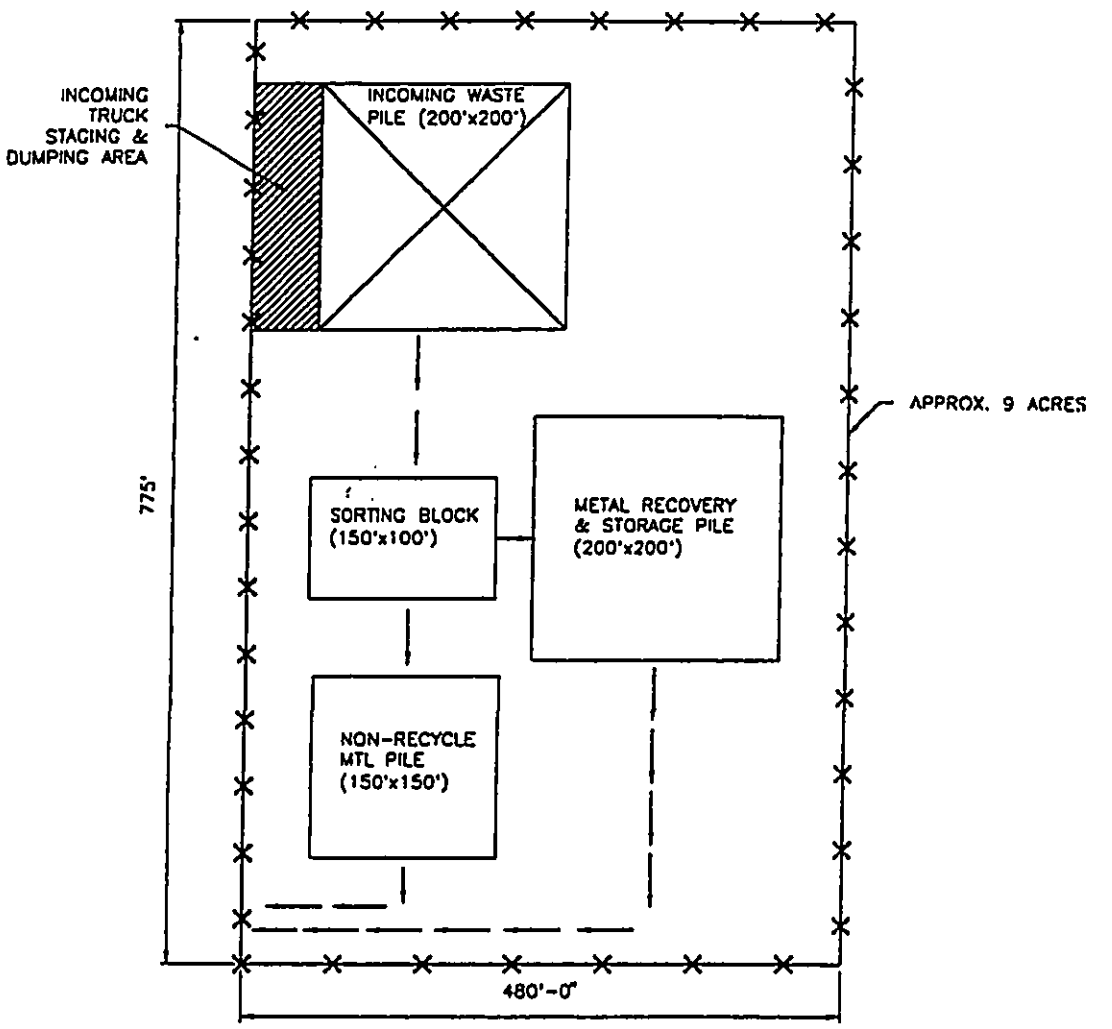


FIGURE 3-14
Land Size Requirements for Metal Recycling Plant

Alternatives Analysis for Disposal of Municipal Solid Waste (MSW)
Dept. Of Environmental Services (ENV) • C & C Honolulu
Waste Management of Hawaii, Inc.

R.M. TOWILL CORPORATION

Source: *New Systems Research for Refuse Disposal,* C & C Honolulu, ENV, April 2000

The metal recycling unit will include magnetic loading devices that will transfer the metals to various unit operations. First the material will be sent to an area for bulk size reduction using large hydraulic shears and balers. The size-reduced material will be placed on a conveyor that leads to a shredder. The metals will be shredded and made ready for shipment to markets.

The plant will consist of the following units/operations:

Incoming Truck Staging & Dumping
Materials Sorting
Bulk Size Reduction
Shredding
Non-Recyclable Waste Loading

3.5.3.2 FUNCTIONAL AND OPERATIONAL REQUIREMENTS

The metal recycling plant is proposed to meet the following functional and operational requirements.

Function - The metal recycling plant will receive, sort and process for recycling bulk and composite material containing ferrous metal. The plant will segregate metals from the incoming wastes and return any non-recyclable refuse to the Waimanalo Gulch Landfill for disposal. Metals will be size reduced and delivered to the recycling companies.

Operations - It is estimated that the metal recycling plant will receive approximately 11.5% (6.7% ferrous metals and the 4.8% mixed/other material) of the 195,000 tons of refuse currently being sent to the Waimanalo Gulch Landfill. This is approximately 22,500 tons per year. The plant will recover approximately 90% of the incoming metal, which is roughly 20,200 tons of metal per year. The remaining amount, approximately 2,300 tons/year, will be sent to a landfill. The plant will operate approximately 7 hours per day, 22 days per month and 12 months per year.

Performance - The metal recovery efficiency will be approximately 90% of the total incoming ferrous metals.

Environmental Permitting - The plant will require a Clean Air Act permit for the dust collector. No other major environmental permits are anticipated. Fugitive emissions will be minimized through design, and will also be subject to permitting. A State DOH Solid Waste Permit will be required for construction and operation of the facility.

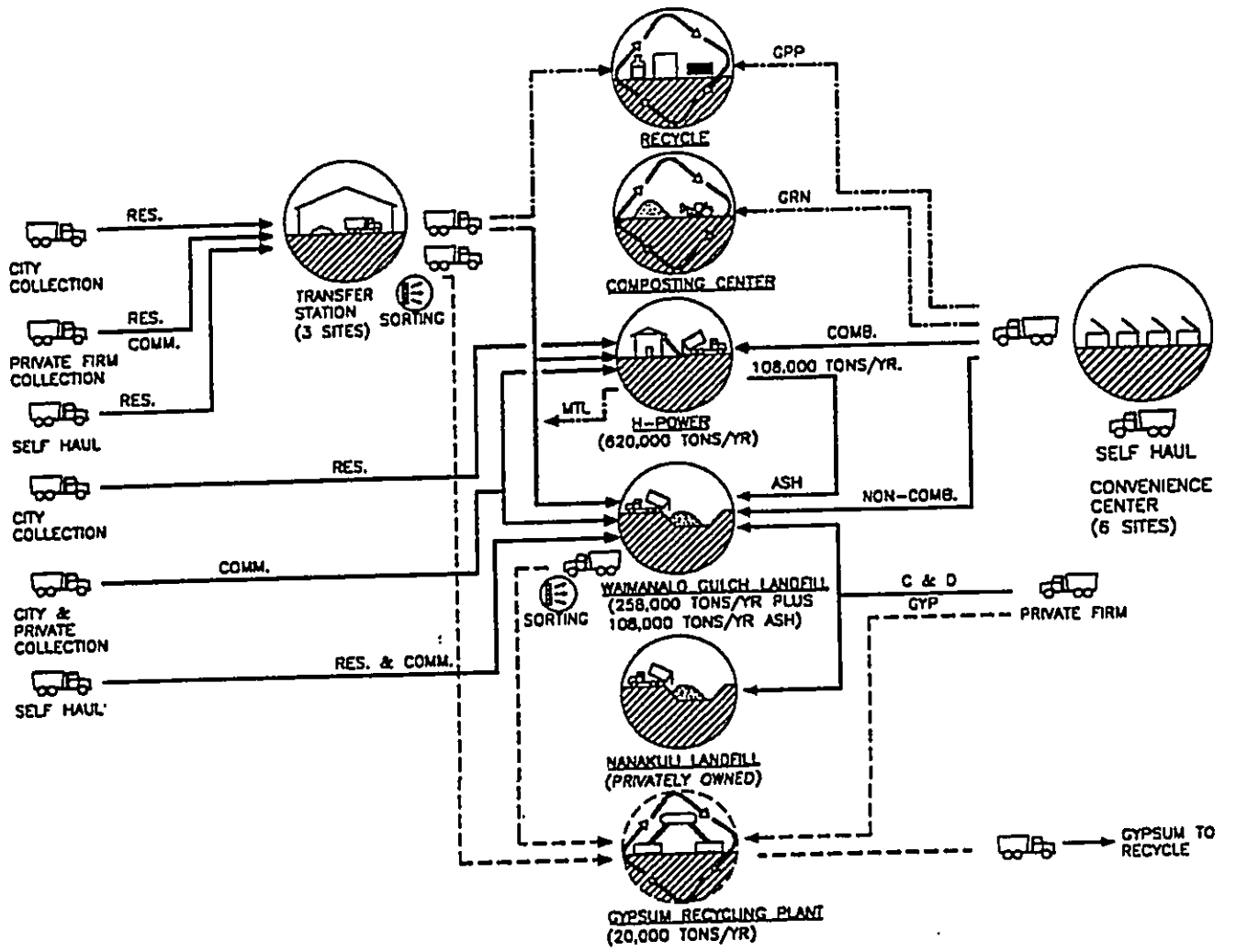
Design, Installation and Construction - The plant will be designed, installed and constructed to meet the national and local codes and standards. All equipment and system will be designed for outdoor installation. Equipment will be pre-assembled and tested at the factory to minimize delays due to field start-up problems.

3.5.4 GYPSUM RECYCLING PLANT

The integration of a gypsum recycling plant into the existing City refuse management system is shown on **Figure 3-15. Figure 3-16,** shows a functional flow diagram for the plant. **Figure 3-17,** shows the footprint for the major unit operations and the overall land requirements for the gypsum recycling plant.

3.5.4.1 FACILITY DESCRIPTION

The gypsum recycling plant will use pulverizing and screening technologies to recover gypsum from gypsum wallboard. The descriptions contained in this report are based on systems being marketed by Andela Tool and Machine, Inc., of Richfield Springs, NY, and Gyp-Pack Container, Inc., of Tonowanda, NY.



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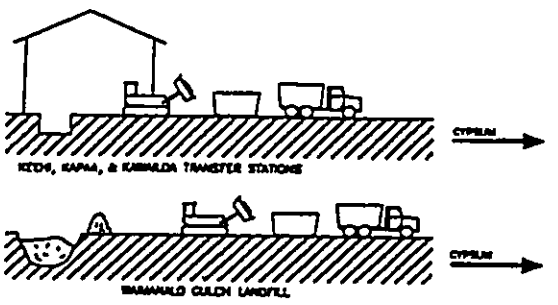
COMB. = COMBUSTIBLE WASTE
C & D = CONSTRUCTION & DEMOLITION
MTL. = METAL RECYCLE
GYP. = GYPSUM DEBRIES
———— EXISTING DISPOSAL FLOW
—·—·— EXISTING RECYCLE FLOW
- - - - - - NEW SYSTEM EVALUATION BY NSR STUDY

FIGURE 3-15
Block Diagram for Integrating Gypsum Recycling Plant into Existing System

Alternatives Analysis for Disposal of Municipal Solid Waste (MSW)
Dept. Of Environmental Services (ENV) • C & C Honolulu
Waste Management of Hawaii, Inc.

R.M. TOWILL CORPORATION

Source: *New Systems Research for Refuse Disposal.* C & C Honolulu, ENV, April 2000



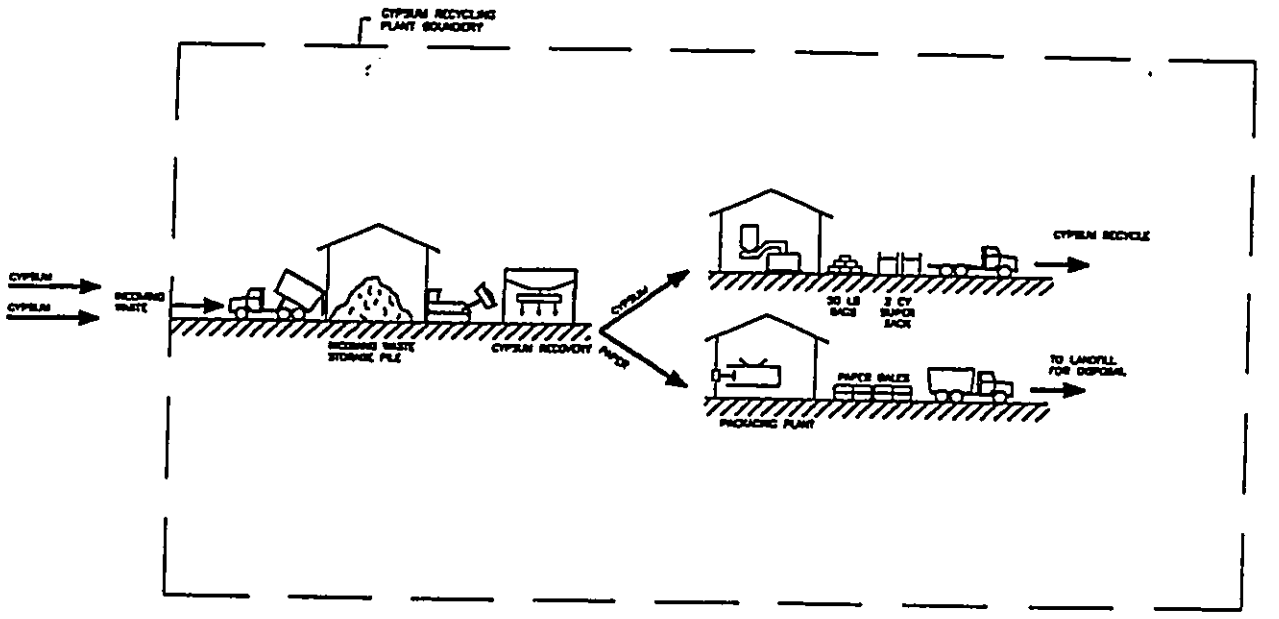


FIGURE 3-16
Block Diagram for Gypsum Recycling Plant

Alternatives Analysis for Disposal of Municipal Solid Waste (MSW)
Dept. Of Environmental Services (ENV) • C & C Honolulu
Waste Management of Hawaii, Inc.

R. M. TOWILL CORPORATION

Source: *New Systems Research for Refuse Disposal,* C & C Honolulu, ENV, April 2000

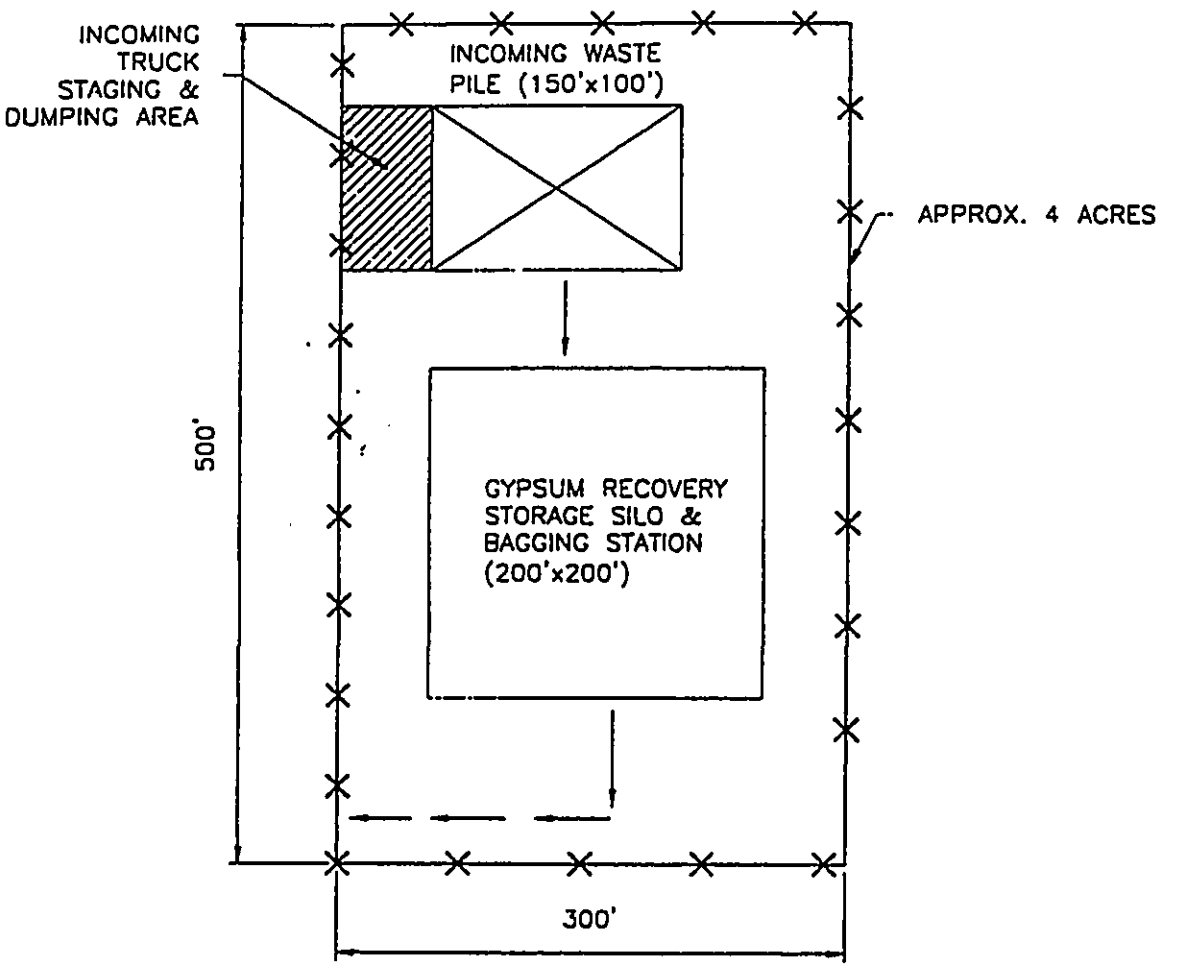


FIGURE 3-17
Land Size Requirements for Gypsum Recycling Plant

Alternatives Analysis for Disposal of Municipal Solid Waste (MSW)
Dept. Of Environmental Services (ENV) • C & C Honolulu
Waste Management of Hawaii, Inc.

R. M. TOWILL CORPORATION

Source: *New Systems Research for Refuse Disposal*, C & C Honolulu, ENV, April 2000

Roll-off bins for gypsum recycling will be placed at a sanitary landfill. The site operator will remove the discarded gypsum wall boards from the incoming refuse and place them in the recycling containers. Trucks, provided by the gypsum recycling plant, will transport the containers to the gypsum recycling plant. Private construction and demolition waste haulers will be encouraged to segregate gypsum-containing refuse at the source and transport it directly to the recycling plant.

The gypsum recycling plant will receive the incoming gypsum, crush and separate the non-recyclable material and package the recyclable gypsum. The packing unit operation will bag gypsum in either 50-pound bags or 2-cubic yard plastic sacks (super-sack). The packaged products will be sold as a soil additive in bags at retail markets or in bulk to the agricultural industry. Sale of recycled gypsum product to other markets, such as oil absorbents in the environmental industry, will also be pursued.

The plant will require an approximately 4-acre site and will have an incoming truck receiving, staging and dumping area. An area in the station will be provided for surge storage of the incoming gypsum wallboard. The storage area will be covered to keep rainwater away from the scrap wallboard storage area.

The scrap wallboard will be spread on a flat area in the storage building. A loader equipped with a wheel crusher/roller will be performing an initial bulk size reduction. The crushed scrap wallboards will then be moved by belt conveyor to the infeed hopper. The hopper delivers a metered quantity of gypsum to a separator.

The separator will remove the paper facing from the gypsum wallboard and break down the gypsum core into powder. The output from the separator is delivered to a trommel separator. The trommel screens the paper from gypsum and deposits each product on a separate conveyor beneath the trommel. The gypsum conveyor delivers the gypsum to the bagging station silos. At the bagging station, gypsum will be filled into special bags and containers

designed for each market. Paper waste will be sent to H-POWER for use as fuel and for energy recovery.

The station will consist of the following units/operations:

Incoming Truck Staging & Dumping
Bagging Station

3.5.4.2 FUNCTIONAL AND OPERATIONAL REQUIREMENTS

The gypsum recycling plant is anticipated to meet the following functional and operational requirements:

Function - The gypsum recycling plant will receive pre-sorted scrap gypsum wallboards. The plant will remove the facing paper from scrap wallboard, grind gypsum to a powder, and bag the powdered gypsum ready for sale in various markets. The paper waste will be taken to H-POWER for use in energy recovery.

Operations - It is estimated that the gypsum recycling plant will receive approximately 7% of the City's refuse that is currently being sent to Waimanalo Gulch. This is equal to 20,000 tons per year. The plant will recover approximately 90% of the incoming gypsum, which is roughly 18,000 tons per year. The remaining amount, approximately 2,000 tons/year, is waste paper that will be sent to H-POWER. The gypsum recycling plant will operate approximately 7 hours per day, 22 days per month and 12 months per year.

Performance - The gypsum recovery efficiency will be approximately 90% of the total incoming scrap gypsum.

Environmental Permitting - The plant will require a Clean Air Act permit for the dust collector. No other major environmental permits are anticipated. Fugitive emissions

will be minimized through design. A State of Hawaii, Department of Health, solid waste management permit will be required for construction and operation of the facility.

Design, Installation and Construction - The plant will be designed, installed and constructed to meet the national and local codes and standards. All equipment and systems will be designed for outdoor installation. Equipment will be pre-assembled and tested at the factory to minimize delays due to field start-up problems.

3.6 EVALUATION OF ALTERNATIVE TECHNOLOGIES

3.6.1 INTRODUCTION

This section contains a technical evaluation of the short-listed alternatives described in Section 3.5.

3.6.2 APPLICATION TO THE EXISTING SYSTEM

3.6.2.1 PLASMA GENERATING STATION

Implementation of the plasma generating station alternative will impact current operations at the City's transfer stations and the convenience centers to the extent that more effort may be needed to prevent disposal of scrap metal. The refuse trucks from these centers and other sources would be diverted to the site where the generation station is located. Landfill operations at Waimanalo Gulch Sanitary Landfill would be reduced significantly.

3.6.2.2 METAL RECYCLING PLANT

The size of the operations at the transfer stations and the Waimanalo Gulch Sanitary Landfill would have to be increased to separate scrap metal.

3.6.2.3 GYPSUM RECYCLING PLANT

The impact of the gypsum-recycling alternative on existing operations are the same as the metal recycling plant. The only difference is that the gypsum recycling plant alternative will not require placing containers at the convenience centers.

3.6.3 EXISTING SYSTEM CHANGES REQUIRED

Changes that would be needed to the existing City municipal refuse management system to use the new system alternatives are as follows:

3.6.3.1 PLASMA GENERATING STATION

Key changes required to implement the plasma generating station alternative involve:

Provide additional space and add scrap metals recycling containers at the transfer stations. Increase operating staff and add magnetic lifting rigs to remove scrap metals from incoming refuse.

Reduce the size of the landfill operations at Waimanalo Gulch Sanitary Landfill to process only ash from H-POWER (approximately 108,000 tons per year) and the non-recyclable material from the plasma generating station (approximately 30,000 tons per year).

3.6.3.2 METAL RECYCLING PLANT

Key changes required to implement the metal recycling plant alternative involve:

Provide additional space and add scrap metals recycling containers at the Waimanalo Gulch Sanitary Landfill. Increase landfill operating staff and add magnetic lifting rigs to remove scrap metal from incoming refuse.

Provide additional space and add scrap metals recycling containers at transfer stations. Increase transfer station operating staff and add magnetic lifting rigs to remove scrap metals from incoming refuse.

3.6.3.3 GYPSUM RECYCLING PLANT

Key changes required to implement the gypsum recycling plant alternative involve:

Provide additional space and add scrap metals recycling containers at transfer stations. Increase transfer station operating staff and add magnetic lifting rigs to remove scrap metals from incoming refuse.

Provide additional space and add scrap metals recycling containers at the Waimanalo Gulch Sanitary Landfill. Increase landfill operating staff and add magnetic lifting rigs to remove scrap metals from incoming refuse.

3.6.4 PROJECT DEVELOPMENT ACTIVITIES AND ESTIMATED DURATION

The following key activities would be required if the options identified in this report are developed, financed and owned by the private sector.

Feasibility Study - A feasibility study that is focused on the selected alternative will need to be undertaken. The feasibility study should include a conceptual design, cost estimate and economic data, detailed marketing research, and an overall strategy for implementing the selected alternative. The study must clearly identify the salient features of the alternative to gain a wide interest from private sector investment groups.

Site Selection - Based on the information provided by the feasibility study, a review must be conducted to identify locations for the proposed plant.

Soliciting Expression of Interest - Soliciting expression of interest from the private sector would be useful before issuing a detailed procurement package. This interim step would ensure that a procurement process takes into consideration the concerns of potential investors.

Procurement - If reliable and credible parties are identified during the expression-of-interest process, then a bid package can be prepared. The bid package would use the information gathered during the feasibility study and the expression-of-interest process. The procurement phase will also include the proposal review and the project award.

Environmental Impact Statement (EIS)/Environmental Assessment (EA) - The project would require an EIS or an EA according to Hawaii Revised Statutes, Chapter 343.

Facility Acquisition - Facility acquisition activities would include design, permitting, construction and start-up requirements.

Estimated schedules for implementing each of the alternatives are summarized in Table 3-3:

TABLE 3-3

Activities and Estimated Duration for Acquiring Alternative Refuse Diversion Facilities

Activity	Activity Duration (Months)		
	Plasma Generating Station	Metal Recycling Plant	Gypsum Recycling Plant
Decision To Proceed	3	3	3
Focused Feasibility Study	9	6	6
Site Selection	6	3	3
Soliciting Expression of Interest	4	2	2
Procurement	6	3	3
Environmental Assessment	18	3	3
Facility Acquisition (design, permitting & construction)	24	12	12
Total Activity Duration	70	32	32

3.6.5 PROJECT MILESTONES

There are two key milestones in the decision-making process to select the alternatives:

Go/No-Go Decision - The first milestone is the decision to pursue one or more of the alternatives considered by this study. This decision would entail funding allocation by the City for the feasibility study, site selection, and expression-of-interest solicitation, as described above.

Funding Source - The second milestone, to be pursued after the conclusion of the expression-of-interest phase, is the financing decision. If no interested private investor is found, the City must develop a strategy for public funding.

3.6.6 PRIOR EXPERIENCE

A discussion of experience gained by communities utilizing the alternative technologies are summarized below:

3.6.6.1 PLASMA GENERATING STATION

The heart of the process is a plasma arc gasification and vitrification system being marketed by Integrated Environmental Technologies, LLC (IET). Several other vendors also provide electric arc melters similar to that used in this alternative. A literature search by the New Systems Research study pointed to several municipal refuse thermal-processing units using melting and gasification technologies (1998 and 1999 IT3 Conference Proceedings). A majority of applications are in Japan and European countries. Detailed information on their operational experience and economical viability was not readily available. Acquisition of such information will require a first-hand examination of data from the operating facilities. A summary of three prior experiences are presented below:

Integrated Environmental Technologies, LLC, (Contact Mr. Jeff Surma at 509/9465700). Battelle Memorial Institute developed this technology and tested it at the Department of Energy site in Hanford, Washington. Battelle licensed this technology to IET. A 10-ton per day engineering scale DC arc plasma system, referred to as PEM™, has been constructed and is available for demonstration. This unit has been used to process a variety of waste streams such as tires, solid waste, sludge, and hazardous wastes.

FMC Corporation, Pocatello, Idaho. Three full-scale electrical arc melter systems that are generally similar to the IET unit have been used by FMC since the mid-1970s. The units receive ores containing phosphorus compounds. The ore is melted to recover elemental phosphorous from the gaseous waste stream. The remaining soil in the ore is discharged from the furnace as molten slag. The molten slag is cooled and is either sent to a storage pile or used as a granular media for road construction. (For the Honolulu application a viable market for the slag will have to be developed to demonstrate feasibility of the technology. If no markets can be developed the slag will require landfilling.)

Allied Technology Group (ATG) GASVIT™ (Contact Bob Julian, Washington State Department of Ecology 509/736-5702). IET has sold a 10-ton per day plasma arc gasification/vitrification unit to ATG. This unit is trademarked by ATG under the name of GASVIT™. This system has received an extensive risk assessment and evaluation by the Washington State Department of Ecology and the US-EPA Region 10 for processing toxic wastes. The unit has received a RCRA/TSCA Part B permit and the full-scale commercial operation was expected by early 2000.

3.6.6.2 METAL RECYCLING PLANT

Metal recycling is a common technology and is employed by industrial facilities generating scrap metal and many municipal refuse systems. There is no technical risk in this technology

as it has been in existence for several decades. The environmental aspects of this technology are also well known.

3.6.6.3 GYPSUM RECYCLING PLANT

Gypsum recycling is an innovative new use of commonly available machinery for pulverization of scrap gypsum and separation of the facing paper. The major barrier is that the market in which a recycled gypsum can be sold is new and in the developmental stage. In order to pursue a gypsum recycling option, the City must first undertake a market development program for recycled gypsum in the Hawaii Islands. A literature survey indicates that a minimum of two plants are practicing gypsum recycling in the US. Operational and economical experience at one of these firms is summarized below.

Construction Debris Recycling Inc. (CDR)(Contact Ben Gordon, 518/271-4491). The CDR facility opened in early 1999 near Albany, NY. The facility accepts drywall and roofing shingles. Gypsum is being processed into agricultural soil additives, construction material, manufacturing ingredients and odor and spill control material. It can be used to compensate for heavy clay soil and soil that is deficient in calcium and sulfur. When added to compost, gypsum can help the retention of nitrogen. Gypsum is also mixed with sand and used as animal bedding in horse stables. Gypsum absorbs urine odors and neutralizes and boosts nitrogen in the field. Paper separated from gypsum can also be used as animal bedding to absorb odor. Experience indicates that gypsum must be manually separated from other construction debris and that the current mechanical sorting technologies have not been effective in this application. CDR's primary revenue stream is from tipping fees. The CDR experience in the mainland U.S. required a tipping fee of $45 to $50 to break even.

3.6.7 PERMITTING

Air emissions, water discharge and land disposal permitting requirements of the alternatives were reviewed. A State DOH, Solid Waste Permit will be required for all alternatives.

The plasma generating station would require both air emissions and water discharge permits. The more significant of the two, the DOH Air Emission Permit, must be obtained for the turbine generators. The plasma system would also need a NPDES Permit for the discharge of wastewater or effluent generated from the syngas cleaning scrubbers. Residual disposal of solid waste from the plasma generating station may or may not be problematic depending on the constituents contained in the glass slag. If the waste composition contains hazardous or toxic components, special treatment would be required. The refuse may also not be permitted for use in construction or for other purposes where the public would be exposed to the waste.

The metal recycling and gypsum recycling plants are expected to require only the Air Emissions Permit for the dust collector exhaust streams. Residual disposal of solid waste from these processes are expected to be covered by the solid waste permit.

Environmental Assessments or Environmental Impact Statements would also be required for the alternatives. At this point, it is judged that the metal and gypsum recycling plants would require only an EA. However, due to its large size and potentially significant impact, the plasma generating station alternative is expected to require an EIS.

3.6.8 OPERATIONAL RELIABILITY

3.6.8.1 PLASMA GENERATING STATION

The heart of this alternative is the plasma system. The durability and life of this system is comparable to a standard electrical arc furnace. This type of furnace is widely used in the mining and metal industry. For example, three large electrode arc furnaces have been operated at the FMC elemental phosphorous plant in Pocatello, Idaho, since the mid-1970s. The plasma process chamber is judged to have no reliability problem in as much as it will use the latest refractory and product discharge mechanisms that have been tested at a smaller scale. However, there is no operational experience at the project scale to support this. Some of the system auxiliary components, such as refuse feeders, process feed controls and syngas

processing units, will require large scale application and long-term operational results in a refuse processing environment in order to establish reliability.

3.6.8.2 METAL RECYCLING PLANT

The heart of this plant is the separation and shredding equipment. These components are high maintenance but can be operated in a reliable manner by instituting a preventative maintenance program.

3.6.8.3 GYPSUM RECYCLING PLANT

The heart of this plant is the device that separates paper facing from wallboards. Proper operation of this equipment will require that the scrap gypsum be dried before it is fed to the crushers. These components are high maintenance items that can be operated in a reliable manner by instituting a preventative maintenance program.

3.6.9 IMPLEMENTATION BARRIERS AND INCENTIVES

Factors that would provide significant incentives and barriers for implementing the alternatives include, but are not limited to, the following:

3.6.9.1 PLASMA GENERATING STATION

The incentives for implementing this alternative are: 1) Much of the refuse stream to a sanitary landfill is diverted; 2) the thermal process is environmentally friendly (i.e., the near elimination of dioxin/furans in the thermal unit exhaust resulting in a final residue of vitrified rock/glass); 3) the process generates syngas which can be used in conjunction with a high efficiency (30%) turbine generator; and 4) the electricity produced by the facility is in high demand.

Impediments for this alternative are: 1) high economic risk because the viability has not been proven, and 2) high technical risk because the technology is first-of-a-kind and has not been proven with a waste stream of comparable quantity and composition as Oahu's.

3.6.9.2 METAL RECYCLING PLANT

Incentives for this option are: 1) the technology and economics are well known; 2) the scrap metal market is well established; and 3) the relatively low level of capital investment will be attractive to private sector investment.

Impediments for this alternative are: 1) The scrap metal price fluctuations increase the investment risk; 2) costs for offshore shipment may be prohibitively high; and 3) the alternative addresses only a small portion (11%) of the current Waimanalo Gulch refuse stream; and 4) Oahu already has effective metals recycling programs and vendors.

3.6.9.3 GYPSUM RECYCLING PLANT

Incentives for implementing this option are: 1) the technology has been used in the past; and 2) the capital investment is relatively low which will be attractive to private investors.

Impediments for this alternative are: 1) the recycled gypsum market and prices are in a developmental stage and, hence, the economic risks are relatively high; 2) the alternative addresses only a small portion (7%) of the solid waste refuse stream going to the Waimanalo Gulch Landfill; and 3) the experience with the technology is short-term (since early 1999).

3.6.10 DIVERSION CAPABILITY

The plasma generating station offers the highest diversion potential. The alternative could divert a major portion of the waste currently being sent to the Waimanalo Gulch Sanitary Landfill. It is expected, however, that 10% of the waste would still need to be sent to the landfill.

The metal and gypsum recycling plants will divert approximately 11% and 7%, respectively, of the material going to the Waimanalo Gulch Sanitary Landfill.

3.7 SUMMARY

The alternatives analysis study identifies three alternative waste disposal technologies with potential for diverting solid waste from Oahu landfills. A summary of major issues that will need to be resolved before each technology can be considered viable for development includes the following:

3.7.1 PLASMA GENERATING STATION

Operational Feasibility and Economic Viability Issues - This technology should be considered an emerging waste reduction method which is still in the process of demonstrating technical, environmental, and economic viability at a scale required for the City and County of Honolulu. Although used for smaller scale applications such as medical waste disposal, a large scale facility will be necessary for the approximately ±200,000 tons of MSW currently requiring disposal in Waimanalo Gulch on Oahu. If refuse received at H-POWER is also diverted for plasma vitrification/gassification, the processing requirement would be even greater.

The proposed plasma generating station will also require the upscaling of existing plasma vitrification/gassification technology. As noted in the alternatives analysis, the proposed plasma gassification with synthetic gas conversion to electricity in a turbine generator, is a relatively immature process. Learning curve information from a large scale facility which could contribute to avoiding costly mistakes have yet to be fully documented for use by governments, municipalities and other users. Adoption of such a system without this information would involve the potential for significant economic risk.

By-Product Generation - Although vitrified glass slag is a by-product that has potential for use in construction materials, research has not yet been completed on the composition of glass slag processed from Oahu MSW. Further, use of the glass slag product will have to be inspected and approved by the State Department of Health, and possibly the Environmental Protection

Agency (EPA), to ensure public safety of the material before use. If the slag is not viable as a construction material, it will have to be landfilled as either MSW or construction/ demolition waste.

Integration into Existing Oahu Refuse Stream - Additional land will be required for this facility and will involve major environmental regulatory review (permits). Adoption of this system will also require that existing refuse disposal streams are redirected from transfer stations, convenience centers, and Waimanalo Gulch Sanitary Landfill. Major logistical considerations and costs, not including the capital and operating cost of the facility, will be incurred to accommodate this new technology. Because the level of effort required will be high, there must be reasonable assurance that the technology is both operationally feasible and technically viable.

Operational Scale - This technology has the potential for operating at a sufficiently large scale which could address a major portion of Oahu's waste stream. The potential for the addition of metals recovery is another positive aspect of the system.

Although not now considered viable for a refuse system as large as Oahu's, it is possible that in the future: 1) large scale operational data may be available which demonstrates the ability of the system to treat a majority of Oahu generated MSW. Vendor technical experience which will demonstrate proficiency will also be available so that there is reasonable assurance of a successful application; 2) operational feasibility may also demonstrate that the cost of plasma gassification/vitrification could be borne at taxpayer expense; and, 3) by-products associated with use of this technology appears environmentally safe and could potentially be used for construction and related activities.

Non-recyclable wastes will still need to be disposed of in a landfill.

3.7.2 METAL RECYCLING PLANT

Operational Feasibility and Economic Viability Issues - As noted, metals recycling is an existing technology with widespread application already in use on Oahu. It is recommended that for the approximately 10 - 15% of metals that are expected to be recovered that a feasibility study be completed to demonstrate economic viability.

By-Product Generation - Non-recoverable metals produced from this process are anticipated to be relatively low in volume. Because this process would recover metals from MSW which would ordinarily be disposed of at a landfill, no further treatment considerations are warranted.

Integration into Existing Oahu Refuse Stream - Metals recovery is already practiced at City transfer stations and convenience centers. This alternative, therefore, will require development of a processing/recovery facility at the existing Waimanalo Gulch Sanitary Landfill. Space requirements, and costs to accommodate additional personnel and equipment will need to be fully determined. This alternative will also require use of space at the existing Waimanalo Gulch Sanitary Landfill which could have some impact on existing operations. Further study in conjunction with the potential for use of the plasma generating station metals recycling component is also necessary to identify both feasibility and likely timeframe for adoption of this alternative.

Operational Scale - Although metals recycling is an established refuse recovery method, it will only provide for a 10 - 15% reduction in the Waimanalo Gulch refuse stream. This will not by itself address the need for landfills, but will contribute to reducing the volume of refuse requiring landfilling.

3.7.3 GYPSUM RECYCLING PLANT

Operational Feasibility and Economic Viability Issues - The process of recovering gypsum is an existing industrial technology which would be applied to refuse recovery. There is some experience with applying this technology to refuse recovery in the U.S. Mainland, although it is still in the emergent phase. A major consideration for Oahu is whether there is sufficient market demand for recycled gypsum products. This is a key consideration since the sale of recycled gypsum is expected to help pay for the cost of the facility.

By-Product Generation - The processing of materials to recover gypsum will produce some waste by-products that cannot be further recovered or recycled. Waste by-products that can be incinerated will be sent to H-POWER for energy recovery. The overall volume of waste by-products are anticipated to be low and comprised of materials which would ordinarily be landfilled.

Integration into Existing Oahu Refuse Stream - Some modifications to the waste refuse stream will be required. This will primarily involve addition of recycling containers at the City's transfer stations and at Waimanalo Gulch. A separate site for the gypsum recycling facility will also be required. Costs and the level of effort required will need to be more fully investigated in a feasibility study. The study should identify both potential locations for the site, personnel and equipment costs, and whether a sufficient market can be identified for development of the system.

Operational Scale - Gypsum recycling is considered an emerging growth technology and will only provide for a 7% reduction in the Waimanalo Gulch refuse stream. This technology will also not by itself address the need for landfills, but will contribute to reducing the volume of refuse requiring landfilling.

SECTION 4
ALTERNATIVE OAHU LOCATIONS FOR SANITARY LANDFILLS

4.1 INTRODUCTION

This section describes requirements for selection and siting of sanitary landfill sites on Oahu. An inventory of potential sites is also documented for further analysis in Section 5. This section contains the following subsections:

- 4.2 Requirements for Selection and Siting of a Municipal Solid Waste Sanitary Landfill
- 4.3 Inventory of Potential Landfill Sites on Oahu

Information contained in this section and Section 5, which follows, is based on investigation and analysis by Department of Environmental Services (ENV), City and County of Honolulu, and review of prior studies including the following:

- Inventory Study of Potential Sanitary and Demolition Landfill Sites, City and County of Honolulu, Department of Public Works, August 1977:
- Supplement to Inventory of Potential Sanitary and Demolition Landfill Sites on the Island of Oahu, City and County of Honolulu, Department of Public Works, November 1979; and,
- Solid Waste Integrated Management Plan, City and County of Honolulu, Department of Public Works, 1995.

4.2 REQUIREMENTS FOR SELECTION AND SITING OF A MUNICIPAL SOLID WASTE SANITARY LANDFILL

Three (3) primary criteria are used to select and site the proposed municipal solid waste landfill:

1. 40 CODE OF FEDERAL REGULATIONS (CFR), PART 258

   Volume 40 of CFR, Part 258, governs the development, operation and closure of landfills. This Federal regulation is administered by the Environmental Protection Agency (EPA), and is delegated to the State of Hawaii, Department of Health (DOH). The State's implementation of 40 CFR 258 is through the DOH Solid Waste Permit Program.

2. LANDFILL CAPACITY REQUIREMENT

   This second criteria involves determination of the capacity for the proposed landfill. The storage capacity requirement is based on the estimated volume of MSW (requiring disposal in a landfill) which would be generated in the City and County of Honolulu for a period of approximately 15 years.

3. TECHNICAL AND RESOURCE CRITERIA

   The third and final criteria involves consideration of the following factors:

   a. Ability to protect natural resources including groundwater, surface water, and air quality;
   b. Compatibility with area land uses including current uses, adjacent uses, proposed development, and future general plans;
   c. Potential for destruction of natural habitat including displacement of species and loss of biotic diversity;
   d. Potential for destruction of cultural resources;

e. Technical viability including engineering feasibility, cover availability, need for further engineering, site access, and availability of utilities;
f. Economic issues including development costs, analysis of haul distances, and material import costs;
g. Anticipated site life; and,
h. Land acquisition issues.

4.2.1 40 CFR PART 258

The development, operation, and closure of landfills is regulated by the EPA, in accordance with Volume 40 of the Code of Federal Regulations (CFR), Part 258, and by the State DOH, through Hawaii Revised Statutes (HRS), Chapter 342, Integrated Solid Waste Management Plan. The State DOH, Solid Waste Permit Program, which incorporates the Federal Municipal Solid Waste Landfill (MSWLF) Criteria, identifies six criteria related to the siting of existing and new municipal solid waste landfills:

1. Location
2. Operation
3. Design
4. Groundwater Monitoring and Corrective Action
5. Closure and Post Closure Care
6. Financial Assurance

1. LOCATION - There are six location restrictions applicable to the siting of landfills. Operators and owners must comply with each of the criteria and maintain records in the facility operating record demonstrating that each of the criteria have been met. These criteria include the following:

RESTRICTION NO. 1: AIRPORT RESTRICTION - Owners/operators must demonstrate that the landfill does not constitute a bird hazard if the facility is located within 10,000 feet of the end of any airport runway used by turbojet aircraft, or within 5,000 of any airport runway used only by piston driven aircraft.

If the owner/operator proposes construction of a landfill or expansion of an existing landfill within 5 miles of any airport, the airport and the Federal Aviation Administration (FAA) must be notified.

RESTRICTION NO. 2: FLOODPLAINS - Landfills located within a 100 year floodplain cannot restrict stormflows within the floodplain, reduce the temporary water storage capacity of the floodplain, or allow the washout of solid waste.

RESTRICTION NO. 3: WETLANDS - Owners/operators of a new or existing landfill may not build or expand into wetlands. An exception to this rule may be permitted by EPA-approved permitting programs to construct or expand a landfill only if the following can be demonstrated:

- No other siting alternative is available;
- Construction and operation of the landfill will not violate applicable State regulations governing water quality or discharges of toxic or hazardous effluent; jeopardize threatened or endangered species, or critical wildlife habitat; or, violate protection of a marine sanctuary;
- The landfill will not contribute to the significant deterioration of the wetland;
- Steps are taken to achieve no net loss of wetlands by avoiding potential for impacts where possible, sufficiently minimizing unavoidable impacts; or, making proper compensation for example, through the restoration of damaged wetlands or the creation of manmade wetlands;

RESTRICTION NO. 4: FAULT AREAS - New landfills or landfill expansions are generally prohibited within 200 feet of fault areas that have shifted since the last Ice Age. However, the director of an authorized EPA permitting program may permit an alternative setback distance of less than 200 feet if the owner or operator can demonstrate that the landfill will maintain structural integrity in the event of a fault displacement.

RESTRICTION NO. 5: SEISMIC IMPACT ZONES - Landfills located in a seismic impact zone must demonstrate that the facility including, but not limited to, its liners, leachate collection system, surface water control system, et. al., has been designed to resist the effects of ground motion due to earthquakes.

RESTRICTION NO. 6: UNSTABLE AREAS - All owners/operators must demonstrate that the structure of their units will not be compromised during geologically destabilizing events including:

- Debris flows resulting from heavy rainfall or storm conditions;
- Fast formation of sinkholes caused by excessive groundwater withdrawal;
- Rockfalls which are initiated by explosives or sonic booms; and,
- The sudden liquefaction of soil after prolonged periods of repeated wetting and drying.

2. OPERATION - Owners/operators must comply with requirements for the management of municipal solid waste landfills. A range of procedures must be adhered to and include:

RECEIPT OF REGULATED HAZARDOUS WASTE - A program to detect and prevent the disposal of regulated quantities of hazardous wastes and PCB (polychlorinated biphenyl) wastes. The program must provide appropriate protocol and procedures for random inspections, record keeping, personnel training to

recognize hazardous and PCB waste, and notification of appropriate authorities if such waste is discovered at the landfill.

COVER MATERIAL - The owner/operator must cover disposed solid waste with a minimum of 6 inches of earthen material at the end of each work day to control vectors, fires, odors, blowing litter, and scavenging. The State DOH may permit the owner or operator to use an alternative cover material or depth, and/or grant a temporary waiver of the cover material if local climate conditions make this requirement impractical.

VECTORS - The owner/operator is responsible for controlling vector populations which include any rodents, flies, mosquitoes, or other animals or insects capable of transmitting disease to humans. Application of cover at the end of each work day will generally control vectors.

EXPLOSIVE GASES - The owner/operator must set up a program to check for methane gas emissions at least every three months. If the regulatory limits are exceeded, the owner/operator mst immediately notify the State DOH and take immediate steps to protect human health and the environment. The owner/operator must also develop and implement a remediation plan within 60 days. The State DOH may modify this interval as appropriate and as consistent with the protection of public health.

AIR QUALITY - Open burning of waste is not permitted by the State DOH.

ACCESS - The owner/operator must control public access to prevent illegal dumping, unauthorized vehicular traffic, and public exposure.

STORM WATER RUNOFF AND RUN ON - The owner/operator must build and maintain a control system designed to prevent storm waters from running on to the active part of the landfill. The run-on control system must also be designed to the 25-year storm flow. The run-off system must similarly be designed to handle storm flows from a 24-hour, 25-year storm event. Run-off waters must be managed in accordance to requirements of the Federal Clean Water Act and Hawaii Administrative Rules (HAR), Chapter 11-54, Water Quality Standards.

SURFACE WATER PROTECTION - All landfills must be operated in such as way that pollutants that violate the Federal Clean Water Act are not inadvertently or intentionally released into waters of the U.S. Appropriate storm water and drainage control measures should be designed to protect surface waters and avoid violations.

3. DESIGN - Criteria for the design of landfills are only applicable to new units and lateral expansions. Existing landfills will not be required to retrofit liner systems. Two options are provided for landfill design criteria:

OPTION 1 - States such as Hawaii, with EPA- Approved National Pollutant Discharge Elimination System (NPDES) permit programs, may authorize the construction of landfills. The Director of the State DOH must ensure that Maximum Contaminant Levels (MCLs, as defined by EPA), will not be exceeded in the uppermost aquifer at a relevant point of compliance. This point is determined by the State DOH, but must be no further than 150 meters from the landfill unit boundary and on land owned by the landfill owner.

Approved authorizing State agencies, such the DOH, must also consider other factors such as the hydrogeological characteristics of the facility and surrounding land, the local climate, and the amount and nature of the leachate.

OPTION 2 - This option involves use of a design developed by EPA that consists of a composite liner and leachate collection system. In general, landfills in jurisdictions without EPA approved programs must use this design. The composite liner system combines an upper liner of a synthetic flexible membrane and a lower layer of soil at least 2 feet thick with a hydraulic conductivity of no greater than 1 x 10^{-7}centimeters/ second. The leachate collection system must be designed to keep the depth of the leachate over the liner to less than 30 centimeters.

4. GROUNDWATER MONITORING AND CORRECTIVE ACTION - Groundwater monitoring is used to demonstrate that the performance of the landfill liner and leachate collection system is operating correctly and poses no potential for negative impacts to groundwater resources. As with all federally mandated requirements, the State DOH may adopt requirements that are more stringent than the Federal criteria. The promulgated criteria for State of Hawaii water quality standards is in HAR, Chapter 11-54, Water Quality Standards. In general, the State water quality standards are consistent with Federal requirements.

Ground water quality monitoring systems must be undertaken for all municipal solid waste landfills. Owner/operators are required to install monitoring wells in appropriate locations to assess water quality: (1) beneath the landfill before any migrating water has passed the landfill boundary. This is to assess pre-existing or ambient conditions; and, (2) at a relevant point of compliance downgradient from the surface of the landfill. Installation and monitoring of monitoring wells shall be in accordance with a qualified water quality monitoring program approved by the State DOH.

Analysis of water quality samples should include specific constituents as required by DOH and EPA. Monitoring frequency may vary depending on requirements. In the event of significant spikes or anomalies involving specific water quality parameters, owners/operators should first assess whether the potential contamination is due to sources other than the landfill, sampling error, or naturally occurring conditions which have caused the deviant

readings. If ground water analysis indicates there is significant contamination that is due to activities at the landfill, and does not include external activities beyond the landfill, errors in monitoring protocol, or naturally occurring conditions, then corrective action or remediation will be required. The level of treatment to which groundwater resources must undergo will be established by the State DOH.

During the remediation or clean up phase ground water quality monitoring must continue at a frequency to be determined by DOH. Public notification is required and a public meeting must be held to advise the public of the groundwater contamination and the proposed corrective action. During implementation of the remediation or clean up phase, water quality monitoring will be used to measure the effectiveness of treatment. In general, once it has been demonstrated by water quality monitoring that clean up efforts are effective, the clean up standard must continue to be met for a specified period of time as determined by DOH or EPA. According to Federal standards, this period must last for approximately three consecutive years.

5. CLOSURE AND POST CLOSURE CARE - All owners/operators are required to follow specific standards when closing a landfill. This includes preparation of a closure monitoring and maintenance plan which becomes part of the landfill operating record.

The final landfill cover must be designed and constructed to have a permeability less than or equal to the bottom liner system or natural subsoils, or a permeability no greater than 1×10^{-5} cm/second, whichever is lower. The final cover must also be constructed of an infiltration layer composed of a minimum of 18 inches of earthen material to minimize the flow of water into the closed landfill. The cover must also contain an erosion layer to prevent the disintegration of the cover. The erosion layer must be a minimum of 6 inches of earthen material capable of sustaining plant growth.

The above standards may be modified by the owner/operator and approved by DOH, if there is an equivalent reduction in infiltration and protection from erosion.

Finally, the owner/operator is responsible for a period of 30 years for maintaining the integrity of the final cover, monitoring groundwater and methane gas, and continuing leachate management and control.

6. FINANCIAL ASSURANCE - The owner/operator must demonstrate financial capability of payment for closure, post closure care, and corrective action for releases of leachate, methane or other landfill contaminants. This requirement may be demonstrated with the following financial instruments:

Trust Fund with a pay-in period;
Surety Bond;
Letter of Credit;
Insurance;
Guarantee;
Assumption of responsibility by the State; and
A combination of the above instruments.

Other financial mechanisms may be employed, but must be approved by the EPA and/or State DOH.

4.2.2 LANDFILL CAPACITY REQUIREMENT

The second major criteria for the siting of a proposed landfill involves provision of sufficient capacity to meet anticipated needs. This will require the provision of long term MSW storage given current and anticipated rates of generation.

ENV has identified a landfill capacity requirement of 15 years based on projected and current rates of waste generation (including 1998 data provided in Section 2). The projected storage requirement is approximately +12 million tons given 820,000 tons of MSW disposed of annually (1998). Of this amount, approximately 620,000 tons of annual capacity will be required to dispose of H-POWER ash, and approximately 200,000 tons of storage capacity from convenience centers, private waste haulers, and municipal sewage sludge (a component of MSW). This would translate to a minimum airspace requirement of 600,000 cubic yards per year for a total of ±9 million cubic yards (600,000 cubic yards x 15 years).

The rationale to provide for this level of storage involves:

1) the need to ensure sufficient storage space given long term historical trends for increasing generation of MSW in the City and County of Honolulu;

2) difficulty with siting of municipal landfills requires that a long term facility location be identified to maximize use of limited land resources on Oahu. Even with use of new technologies which will facilitate the reduction of MSW, both existing and new technologies will require periodic down periods for maintenance, repair, or replacement of machinery. During these periods it is expected that MSW will require disposal in a landfill;

3) the need to minimize potential for environmental impacts associated with use of two or more separate and smaller landfill facilities. The proposed development of a municipal landfill will involve the major commitment and use of both financial and environmental resources. Use of a single facility is anticipated to result in lower potential for environmental impacts than two or more separate sites. At the same time, the use of a single facility will require that the site be capable of providing sufficient capacity to meet anticipated needs;

4) economies of scale from an appropriately sized facility would generally allow for lower refuse disposal costs than a smaller landfill. This is because: a) a smaller landfill will reach exhaustion of capacity in a shorter period of time than a larger facility; and 2) the cost of developing a smaller landfill combined with a shorter period of use can be expected to result in higher disposal costs on a per ton basis; and,

5) the State of Hawaii and its major islands are subject to periodic natural weather influences including tropical storms and hurricanes. A landfill facility of sufficient size must be available to facilitate clean up efforts and the disposal of debris. This function is for the maintenance of public health, safety, and welfare.

4.2.3 TECHNICAL AND RESOURCE CRITERIA

The final selection criteria involves evaluation of technical and resource issues which would constrain development of a landfill. There are a total of seven (7) criteria which includes the following:

4.2.3.1 PROTECTION OF NATURAL RESOURCES

The proposed project site must be in a location which would not result in potential for negative adverse impacts to groundwater, surface water, and air quality.

Groundwater resources of Oahu are protected through the State DOH, Underground Injection Control (UIC) program, and the City and County of Honolulu, Board of Water Supply (BWS), Groundwater Zones.

The UIC program was established in 1984. The purpose of the program is to protect the State's potable groundwater resources from pollution by subsurface wastewater disposal. The

program regulations are accompanied by UIC maps which demarcate a boundary line known as the "UIC Line." Lands that are landward of the UIC Line are not permitted for use by landfills. Lands seaward of this line, however, are not restricted from subsurface wastewater disposal by underground injection (**Figure 4-1**). Sanitary landfills and waste disposal facilities may therefore be sited makai of this zone.

Prior to 1987, groundwater recharge areas for the Island of Oahu were identified by BWS. Since 1987, the State Department of Health has administered the No Pass Program (**Figure 4-2**). The BWS Groundwater Zones identify areas of groundwater recharge, areas of brackish groundwater supplies, and additional areas which may be acceptable for landfill development. Areas which are considered critical for groundwater recharge have been designed the "No Pass Zone." Within this area sanitary landfill and waste disposal systems are generally not permitted. All other areas are identified as within the "Pass Zone" and have been determined to be areas where landfills and shallow waste disposal systems may be permitted. These facilities are limited to a maximum depth of 30 feet.

Protection of ground and surface water, and air quality from facilities such as sanitary landfills are through the existing environmental permit process. Protection of ground and surface waters is delegated by the EPA to the State DOH under provisions of the Federal Safe Drinking Water Act (SDWA) and Clean Water Act (CWA). These federal regulations enable the State DOH to protect Hawaii's drinking and surface waters from the siting of facilities, such as sanitary landfills, through Hawaii Administrative Rules (HAR); Chapter 11-23, Underground Injection Control; Chapter 11-55, Water Pollution Control, and the National Pollutant Discharge Elimination System (NPDES) Permit program. Regulation of air quality standards are similarly delegated from the EPA to the State DOH, through the Clean Air Permit. Landfill siting under existing regulations, therefore, only allow for facilities outside of the UIC Line and BWS Groundwater Zone provided that sufficient mitigation measures and operations practices are used.

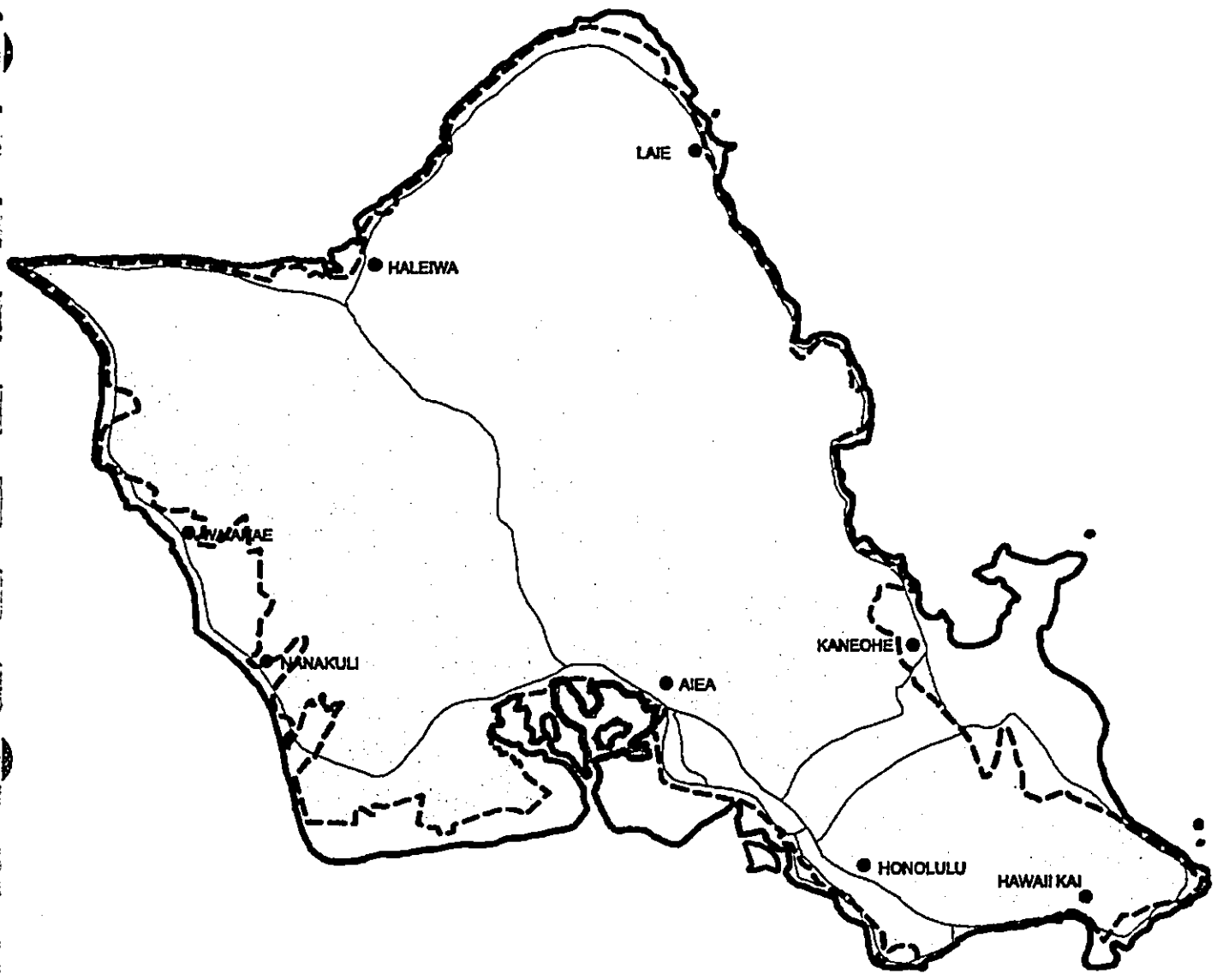


FIGURE 4-1
UIC Line

0 2 4 6 8 10 12 MILES

Alternatives Analysis for Disposal of Municipal Solid Waste (MSW)

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* Source: DOH, 2001

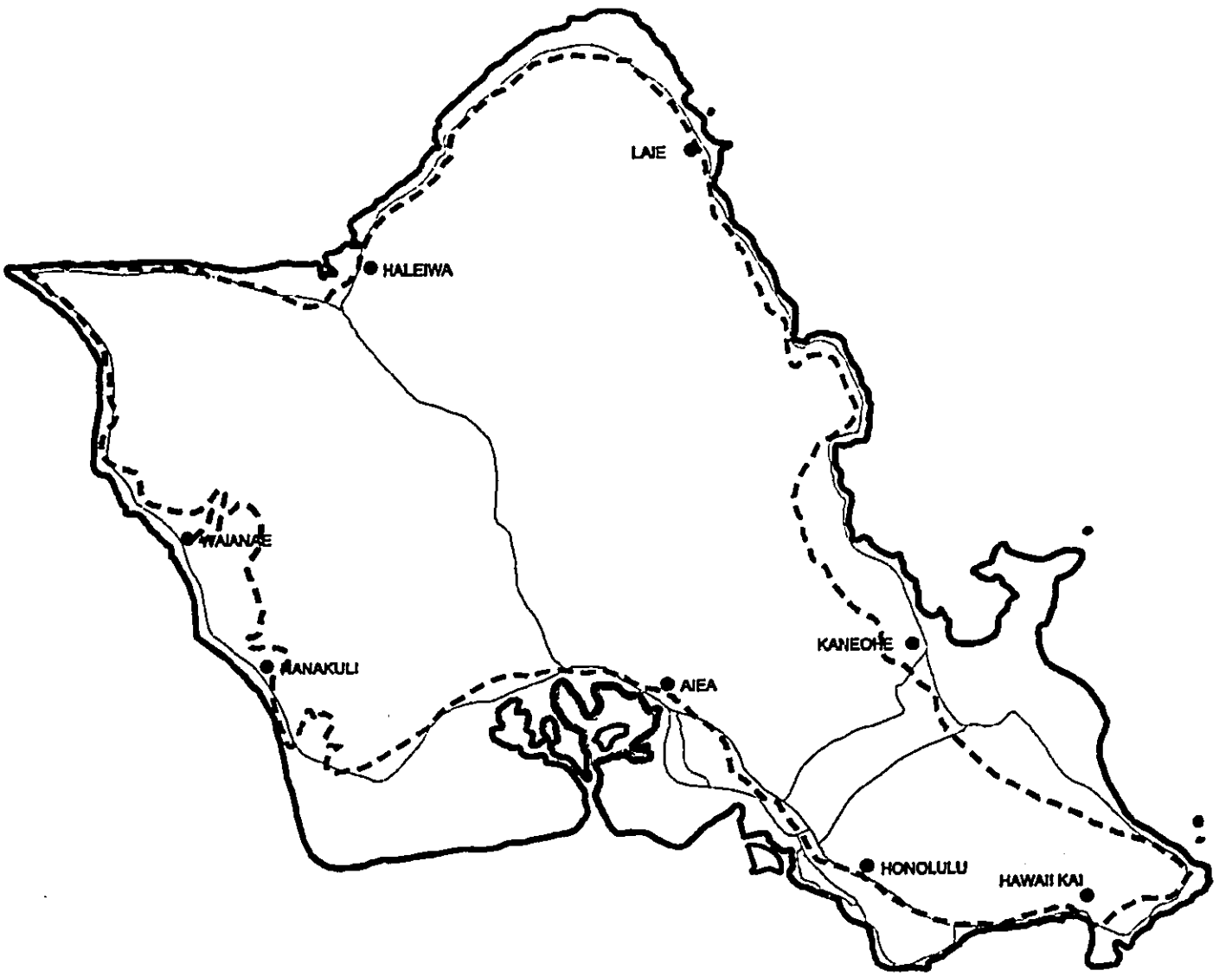

FIGURE 4-2
Board of Water Supply
Groundwater Protection Zone

0 2 4 6 8 10 12 MILES

Alternatives Analysis for Disposal of Municipal Solid Waste (MSW)

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Waste Management of Hawaii, Inc.

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* Source: Board of Water Supply, 2001

4.2.3.2 COMPATIBILITY WITH AREA LAND USE

Under ideal conditions the siting of a sanitary landfill would be directed to locations with compatible surrounding land uses such as industrial parks, reclamation facilities, or other lands which would be considered marginal for public purposes.

The existing land use situation on the Island of Oahu, however, provides no ideal conditions where the siting of a landfill would prove compatible with either current and adjacent land uses or proposed and future plans for development. The existing land use situation involves the requirement that major portions of Oahu's interior, which provides for groundwater recharge, remain restricted to development of municipal landfills. Unfortunately, lands which remain for development are generally along the coastal areas of the island, which are also conducive for residential, resort, recreational and commercial, as well as industrial land uses.

This requires that landfill sites be selected with care and consideration for potential impacts to both the affected community as well as the environment. Although guidelines are generally available to develop mitigation measures to address technical issues involving viewplanes, control of waste hauling vehicles, windblown litter, and odor, no clear guidelines are available to address the public perception of a landfill within any given community.

The following measures are therefore, proposed to ensure landfill development that is as compatible as possible within an area's land use:

1. Appropriate discussion and dialog with the affect area population to incorporate community concerns and to address issues associated with landfill development;

2. The opportunity for public discussion should be extended or offered to the broader island community. This is because the selection and development of a landfill will serve the entire island and result in both the long term benefit of allowing for a location for waste disposal, as well as potential costs associated with need for minimization or mitigation of nuisance associated issues;

3. Development of mitigation measures must be consistent with the continued efficient and effective operation of the City and County of Honolulu. This requires that any proposed mitigation measures be applied in an equitable and fair manner to reasonably address the stated concerns of the affected community. A system of accountability to ensure mitigation measures are adequately implemented and deployed over time should be used; and,

4. Because of major public concern over the future of remaining land resources on Oahu and the long term public need to provide for landfills, other venues for disposal of MSW should continue to be investigated. Although not now viable, alternatives as described previously, including plasma arc incineration, and gypsum and metals recycling, should continue to be investigated. As these new technologies become both technically and economically feasible, the City (and private sector interests) should be encouraged to adopt them.

4.2.3.3 PROTECTION OF NATURAL HABITAT

Landfills should generally not be sited in locations which serve as habitat for Federal or State listed threatened or endangered species. This is to ensure protection against displacement of species and loss of biodiversity unique to Hawaii.

4.2.3.4 PROTECTION OF CULTURAL RESOURCES

Landfills should not be located in places with known significant archaeological or historic cultural sites. If there are any questions concerning whether a location may contain significant historic resources, an archaeological reconnaissance should be taken. Based on results of the reconnaissance, further archaeological inventory as well as discussion with appropriate organizations including the Oahu Burial Council, or local individuals with knowledge about undocumented family burial sites, should be completed to determine appropriate mitigation or other remedial actions.

4.2.3.5 TECHNICAL VIABILITY

Technical viability includes evaluation of engineering feasibility, cover availability, site access, and availability of utilities.

Engineering feasibility involves the level of effort required to engineer various features of the site including maximum working slopes, appropriate depth, and finished height of the landfill. Under certain conditions, an extraordinarily high level of engineering effort would result in construction costs which would make the project infeasible for development.

Landfill development also requires sufficient cover material available at the end of each working day to cover MSW within the active working cell. Typically, the soil cover is obtained from the landfill site itself with some importation of cover material on an as needed basis. Potential sites with little to no soil cover would require additional expense due to need for large scale importation of material.

Site access and availability of utilities are also critical components to use of a landfill site. Site access involves whether adequate circulation can be designed for vehicles entering and exiting the site and whether sufficient space for queuing of vehicles can be provided during landfill operating hours.

4.2.3.6 ECONOMIC DEVELOPMENT COSTS

Evaluation of economic development costs include factors such as the overall cost of development of the site, analysis of haul distances, and material import costs. Site development costs primarily include costs to construct administrative and operational facilities. Analysis of haul distances involves the routes which vehicles must travel to deliver MSW to the landfill site. Material import costs involve whether there is sufficient soils available on-site for use as landfill cover. If soils or an alternative cover material must be brought to the site, the cost would need to be factored as an additional development cost.

4.2.3.7 LAND ACQUISITION ISSUES

A number of criteria which would constrain acquisition of land have already been described above and include potential for adverse environmental, cultural, and economic impacts. A number of other factors, however, could also affect acquisition of land. At least three additional criteria include:

1. Public or private land ownership - Publicly owned land is generally considered more advantageous for development. Because public land is already held in the public trust, some of the costs associated with acquisition including transfer fees, closing and related costs may not be required. Although it is possible for government to condemn privately held land, thereby providing the opportunity for a lower potential acquisition cost, resentment and ill will from the landowner (and potentially, public interest and community groups and organizations) could result. In addition, if privately held land must be

purchased, costs would need to be budgeted and could constrain: 1) availability of the site given the purchase cost; and, 2) length of time required before the site could become available.

2. Issues associated with public use of the land - This involves whether there are public use issues associated with social or cultural events, activities or practices on the potential landfill site. Future encumbrance of the land for preservation or land banking purposes in the pubic interest may also constitute a restriction.

3. Location of the landfill in relation to existing or proposed future development - Because the development of landfills must be restricted to locations outside of the BWS "No Pass Zone" and DOH UIC Line, there is increased potential for conflicts due to the coincidence of use of available land for both landfill and other public and private purposes. These land uses would include residential, commercial, or recreational development, and public preservation uses.

4.3 INVENTORY OF POTENTIAL LANDFILL SITES

4.3.1 INTRODUCTION

ENV has identified a total of 42 landfill sites based on on-going analysis and preliminary review of locations with potential for development. These sites are identified in **Figure 4-3.** **Table 4-1** provides an itemized listing including location by name, area (by approximate TMK location), acreage, capacity, and anticipated lifespan based on waste disposal requirements of the City and County of Honolulu.

4.3.2 SITE LOCATIONS AND CHARACTERISTICS

This section provides an itemized description of each of the landfill sites:

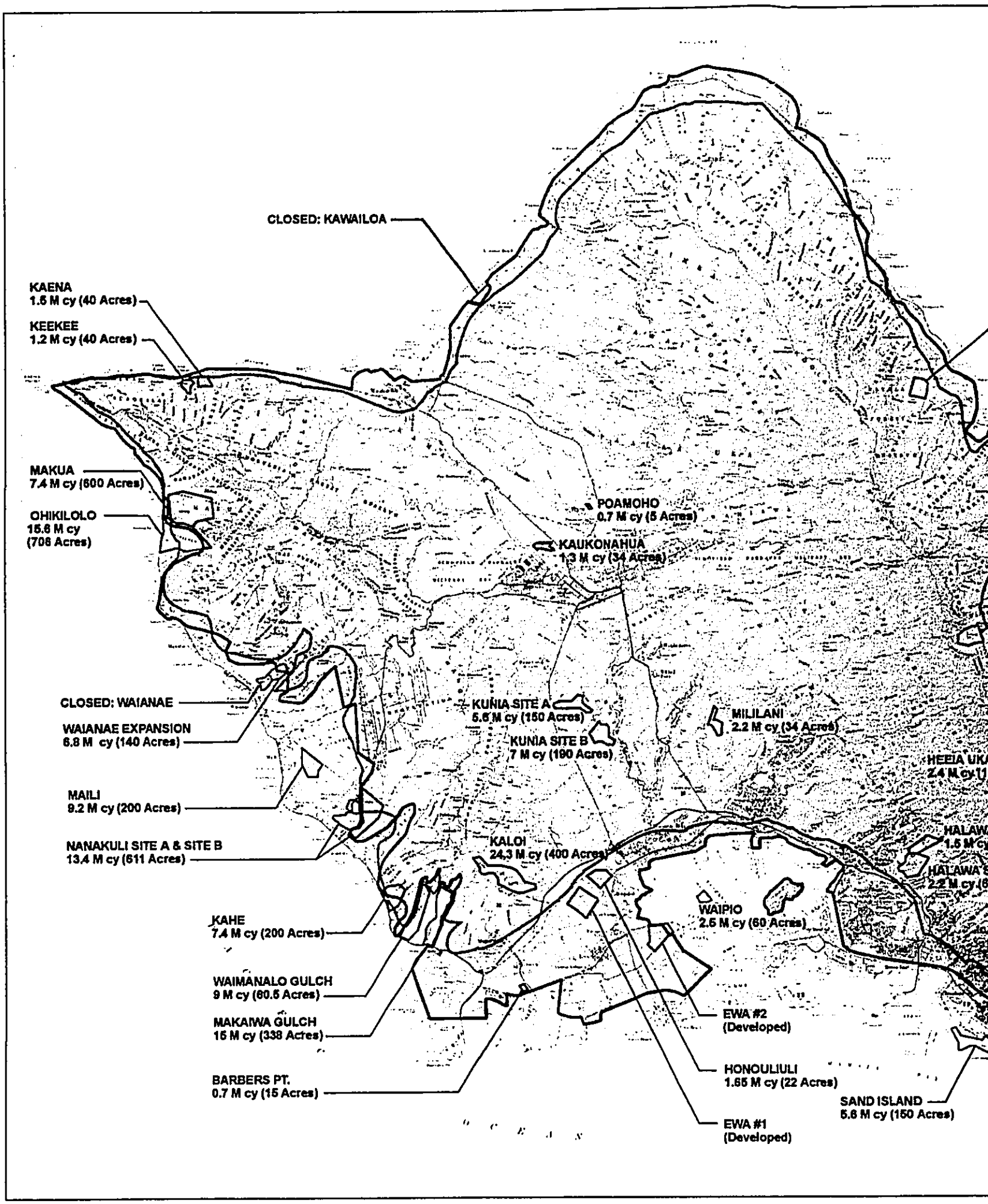
CLOSED: KAWAILOA
KAENA
1.6 M cy (40 Acres)
KEEKEE
1.2 M cy (40 Acres)
MAKUA
7.4 M cy (600 Acres)
OHIKILOLO
15.6 M cy
(706 Acres)
POAMOHO
0.7 M cy (5 Acres)
KAUKONAHUA
1.3 M cy (34 Acres)
CLOSED: WAIANAE
WAIANAE EXPANSION
6.8 M cy (140 Acres)
MAILI
9.2 M cy (200 Acres)
NANAKULI SITE A & SITE B
13.4 M cy (611 Acres)
KUNIA SITE A
5.6 M cy (150 Acres)
KUNIA SITE B
7 M cy (190 Acres)
MILILANI
2.2 M cy (34 Acres)
KALOI
24.3 M cy (400 Acres)
KAHE
7.4 M cy (200 Acres)
WAIMANALO GULCH
9 M cy (60.5 Acres)
MAKAIWA GULCH
15 M cy (338 Acres)
BARBERS PT.
0.7 M cy (15 Acres)
WAIPIO
2.5 M cy (60 Acres)
EWA #2
(Developed)
HONOULIULI
1.65 M cy (22 Acres)
EWA #1
(Developed)
SAND ISLAND
5.6 M cy (150 Acres)

Figure 4-3
ALTERNATIVE LANDFILL SITES
Island of Oahu

Alternatives Analysis for Disposal of Municipal Solid Waste (MSW)
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Waste Management of Hawaii, Inc.

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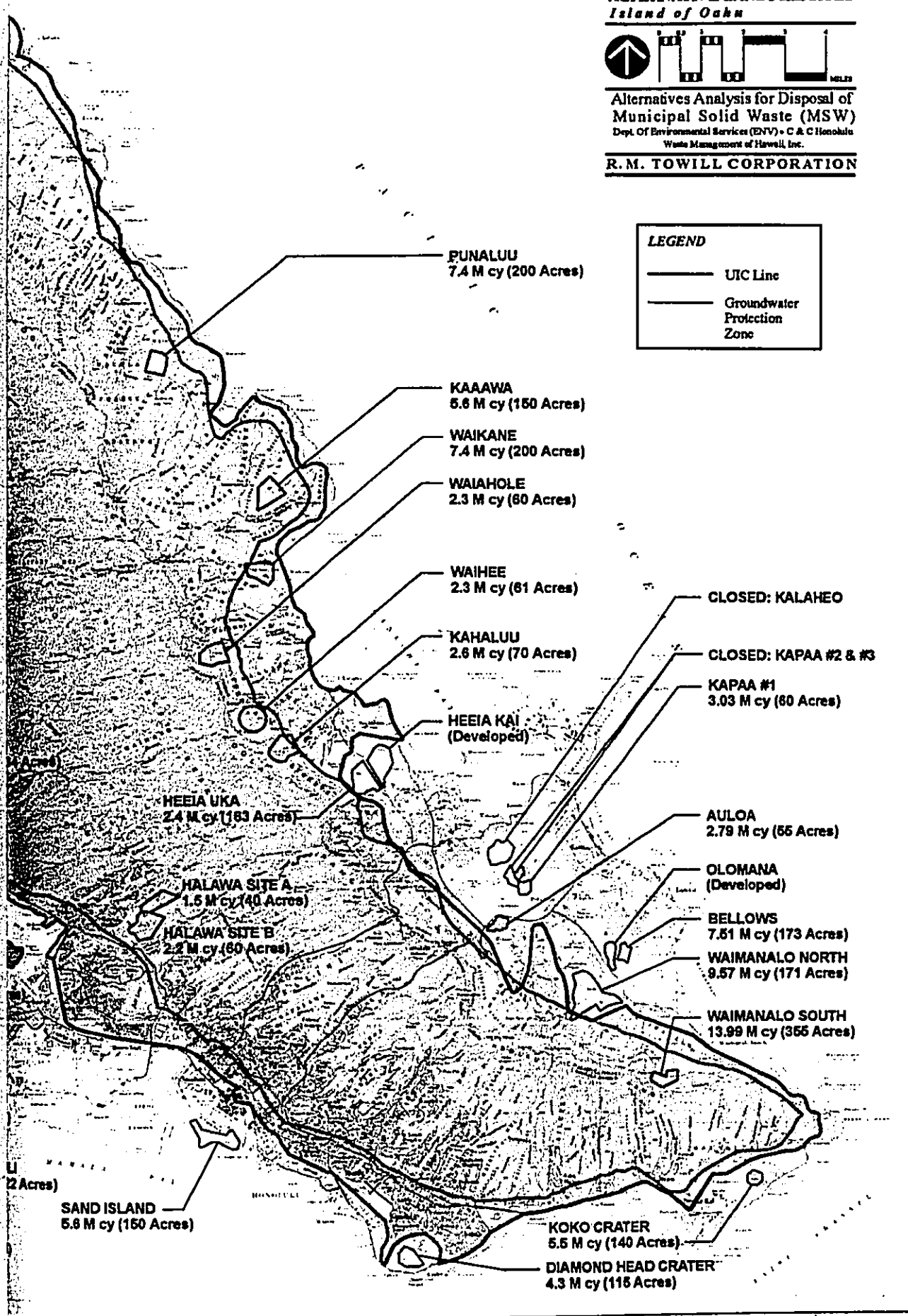


TABLE 4-1

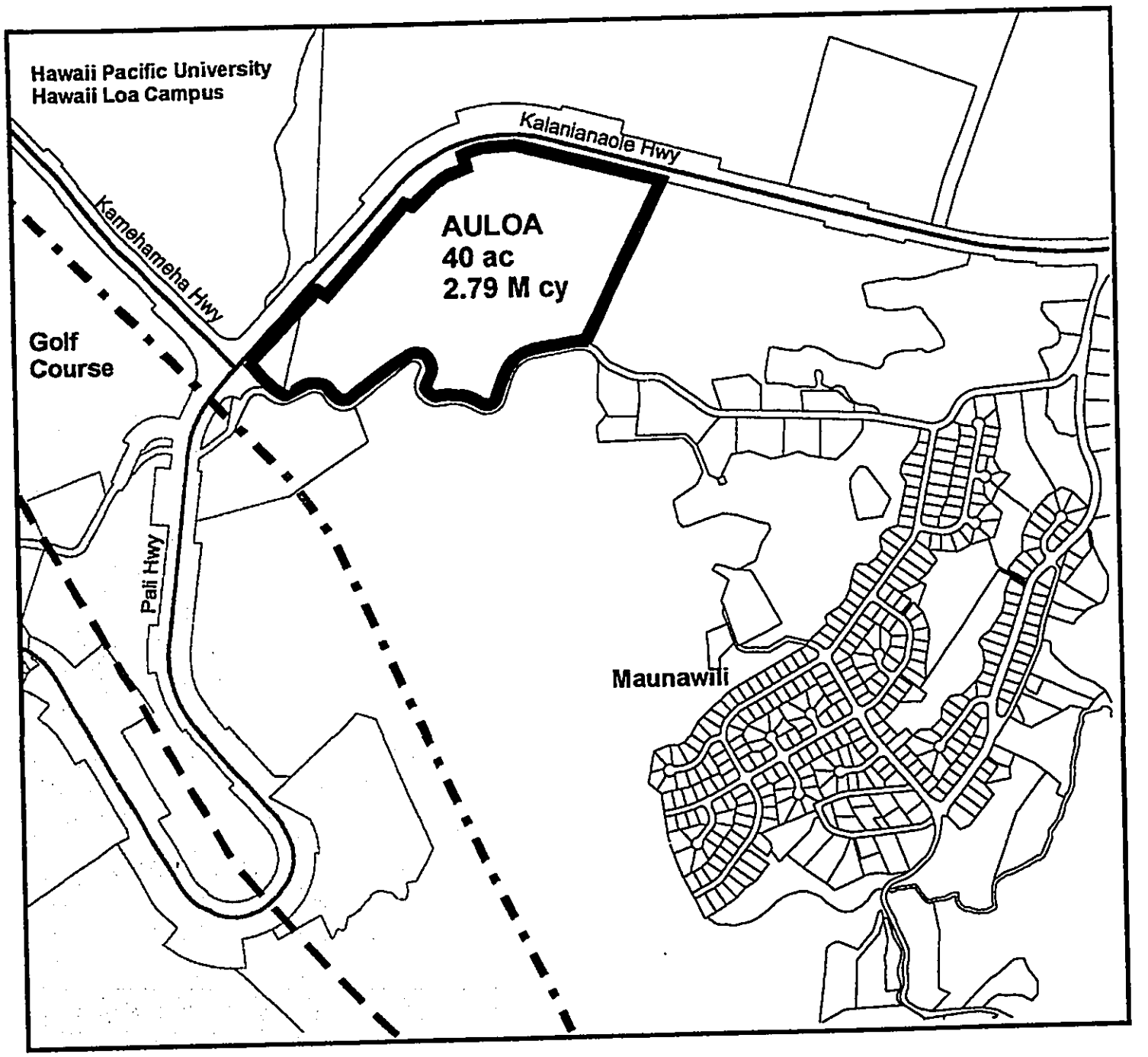
INVENTORY OF POTENTIAL ALTERNATIVE LANDFILL SITES
ISLAND OF OAHU

No.	Site Name	TMK	Total Acreage	Mill. Tons Capacity*	Years Lifespan**
1	Auloa	4-2-14:por 1	55.00	2.79	4.7
2	Barbers Point	9-1-16:18, por 1	15.00	0.74	1.2
3	Bellows	4-1-15	173.00	7.51	12.5
4	Diamond Head Crater	3-1-42:por 6	115.00	4.30	7.2
5	Ewa No. 1	9-1-17	210.00	12.00	20.0
6	Ewa No. 2	9-1-10	200.00	6.90	11.5
7	Halawa A	9-9-10:8,9,por 10 & 26	40.00	1.50	2.5
8	Halawa B	9-9-10:27, por 10	60.00	2.20	3.7
9	Heeia Kai	4-6	-	-	-
10	Heeia Uka	4-6-14:01	163.00	2.40	4.0
11	Honouliuli	9-1-17:por 4	22.00	1.65	2.8
12	Kaaawa	5-1	150.00	5.60	9.3
13	Kaena	6-9-1:por 3, 33 & 34	40.00	1.50	2.5
14	Kahaluu	4-7	70.00	2.60	4.3
15	Kahe	9-2-3:por 27	200.00	7.40	12.3
16	Kalaheo (closed)	4-2-15:por 1 & 6	130.00	5.90	9.8
17	Kaloi	9-2-02:por 1; 9-2-3:por 2; 9-2-4:por 5	400.00	24.30	40.5
18	Kapaa No. 1	4-4-14:por 2	60.00	3.03	5.1
19	Kapaa No. 2 & 3 (closed)	4-2-15:por 1, 3, 4, 7	74.00	2.38	4.0
20	Kaukonahua	7-1	34.00	1.30	2.2
21	Keekee	6-9-1:por 3 & 4, 6-9-3: por 2	40.00	1.20	2.0
22	Koko Crater	3-9-12: por 1	140.00	5.50	9.2
23	Kunia A	9-4-4: por 4	150.00	5.60	9.3
24	Kunia B	9-4-3: por 19	190.00	7.00	11.7
25	Maili	8-7-10:3	200.00	9.20	15.3
26	Makaiwa	9-2-3	338.00	15.00	25.0
27	Makua	8-1-1, 8-2-1	600.00	7.40	12.3
28	Mililani	9-5	34.00	2.20	3.7
29	Nanakuli	8-7-9:1 &3 and 8-7-21:26	611.00	13.40	22.3
30	Ohikilolo	8-3-1:13	706.00	15.60	26.0
31	Olomana	4-2	-	-	-
32	Poamoho	7-1	5.00	0.70	1.2
33	Punaluu	5-3	200.00	7.40	12.3
34	Sand Island	1-5-41	150.00	5.60	9.3
35	Waiahole	4-8	60.00	2.30	3.8
36	Waianae Expansion	8-5-3 and 6	140.00	6.80	11.3
37	Waihee	4-7	61.00	2.30	3.8
38	Waikane	4-8	200.00	7.40	12.3
39	Waimanalo Gulch Expansion	9-2-3: 72 & 73	60.50	9.00	15.0
40	Waimanalo North	4-1-08:13	171.00	9.57	16.0
41	Waimanalo South	4-1	355.00	13.99	23.3
42	Waipio	9-3-2	160.00	2.50	4.2

*Capacity is based on analysis of site characteristics, slope, and area available for development by ENV.
**Lifespan is based on capacity divided by disposal rate of 600,000 cubic yards MSW per year.

1. AULOA - Located south of Kalanianaole Highway, north of Auloa Road and east of the intersection at Castle Junction in Kailua. This site is comprised of a moderately deep depression between Kalanianaole Highway and Auloa Road. Elevation ranges from approximately 90 feet and rises to 330 feet relative to mean sea level (MSL). The average slope of the site is 10 percent with a low of 3 percent to a high of 40 percent. **(Figure 4-4)**.

TMK:	4-2-14:por 1
Acreage:	±55 (±40 usable)
Ownership:	Trust of Harold K.L. Castle, Moanalua Farms, Limited
Adjoining Land Uses:	Adjacent to residential communities of Kailua and Maunawili. Hawaii Pacific University lies to the northwest and the Pali Golf Course lies immediately to the west, across Kamehameha Highway.
Cover Material:	Available on site
Soils Classification:	Helemano silty clay, 30% to 90% slopes Alaeloa Silty clay, 15% to 35% slopes Alaeloa silty clay, 40% to 70% slopes Hanalei stony silty clay, 2% to 6% slopes
City and County of Honolulu Zoning:	Ag-1
State Land Use District:	Conservation
Capacity:	2.79 million cubic yards
Lifespan:	±4.7 years (based on 0.6 million cubic yards per year required)



LEGEND

- Site Boundary
- Underground Infiltration Control (UIC) Line
- Groundwater Protection Zone (GPZ) Line

FIGURE 4-4
Auloa

0 500 1000 1500 2000 FEET

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Waste Management of Hawaii, Inc.

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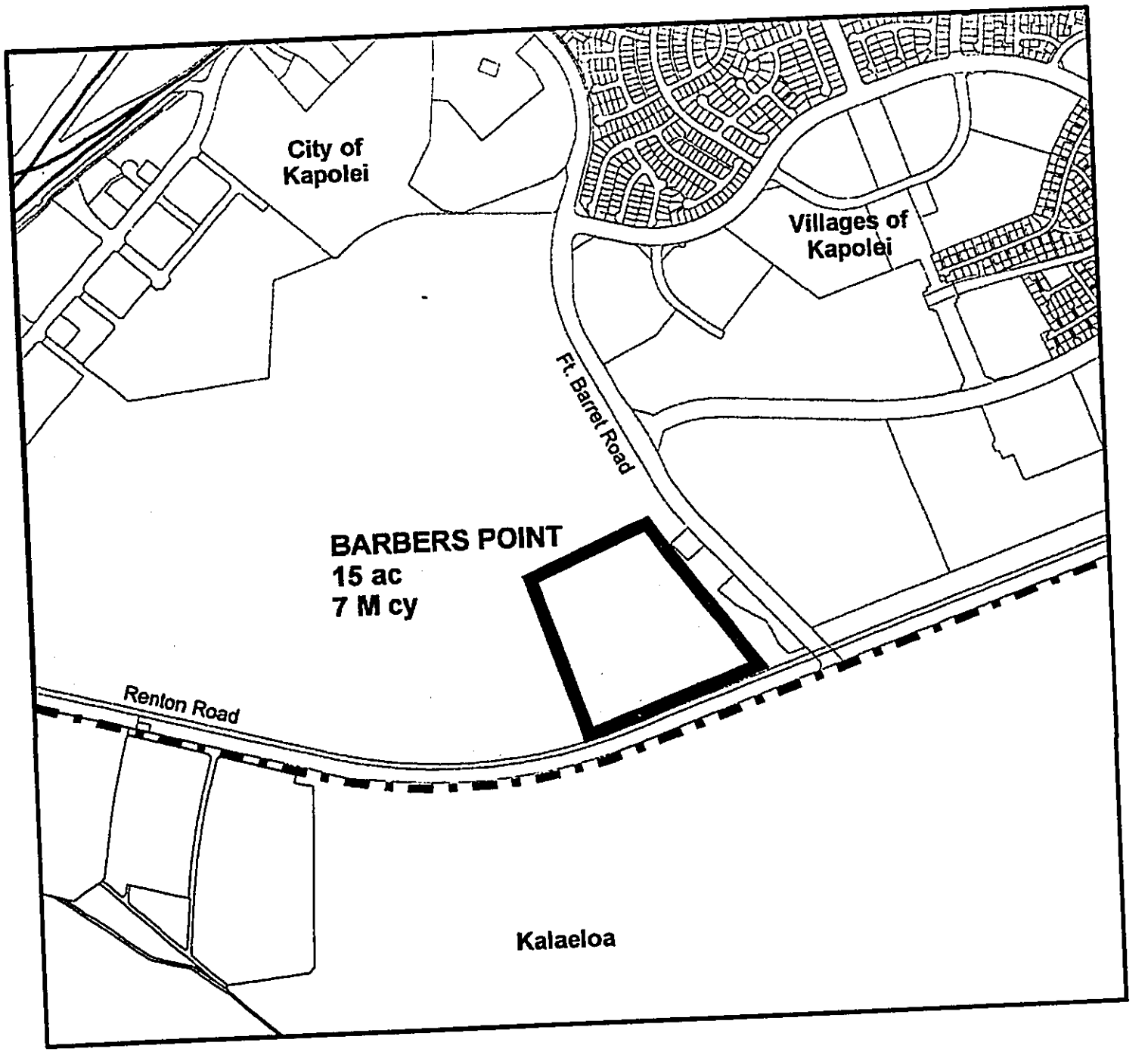
* Source: C & C Honolulu, ENV 2001
IDS Maps 1998, C & C Honolulu

2. **BARBERS POINT** - Located immediately north of the former Barbers Point Naval Air Station, approximately 1.5 miles south of H-1 freeway, approximately 2 miles southeast of Makakilo. The site is a former pit created through previous coral quarrying activity. Elevation of the site is approximately 40 feet MSL. **(Figure 4-5)**

TMK:	9-1-16:18 & por 1
Acreage:	±15
Ownership:	Estate of James Campbell
Adjoining Land Uses:	Adjacent to major residential communities of Kapolei to the north, Ewa Villages to the east, and to the south, military residences of the former Barbers Point Naval Air Station. The pit and surrounding area is situated within the Ewa Plain.
Cover Material:	Must be imported
Soils Classification:	Ewa silty clay loam, moderately shallow, 0 to 2% slopes Mamala stony silty clay loam, 0 to 12% slopes Coral outcrops
City and County of Honolulu Zoning:	Ag-1
State Land Use District:	Agricultural
Capacity:	0.74 million cubic yards
Lifespan:	±1.2 years (based on 0.6 million cubic yards per year required)



LEGEND

———	Site Boundary
- - - -	Underground Infiltration Control (UIC) Line
OUTSIDE	Groundwater Protection Zone (GPZ) Line

FIGURE 4-5
Barbers Point

0 500 1000 1500 2000
FEET

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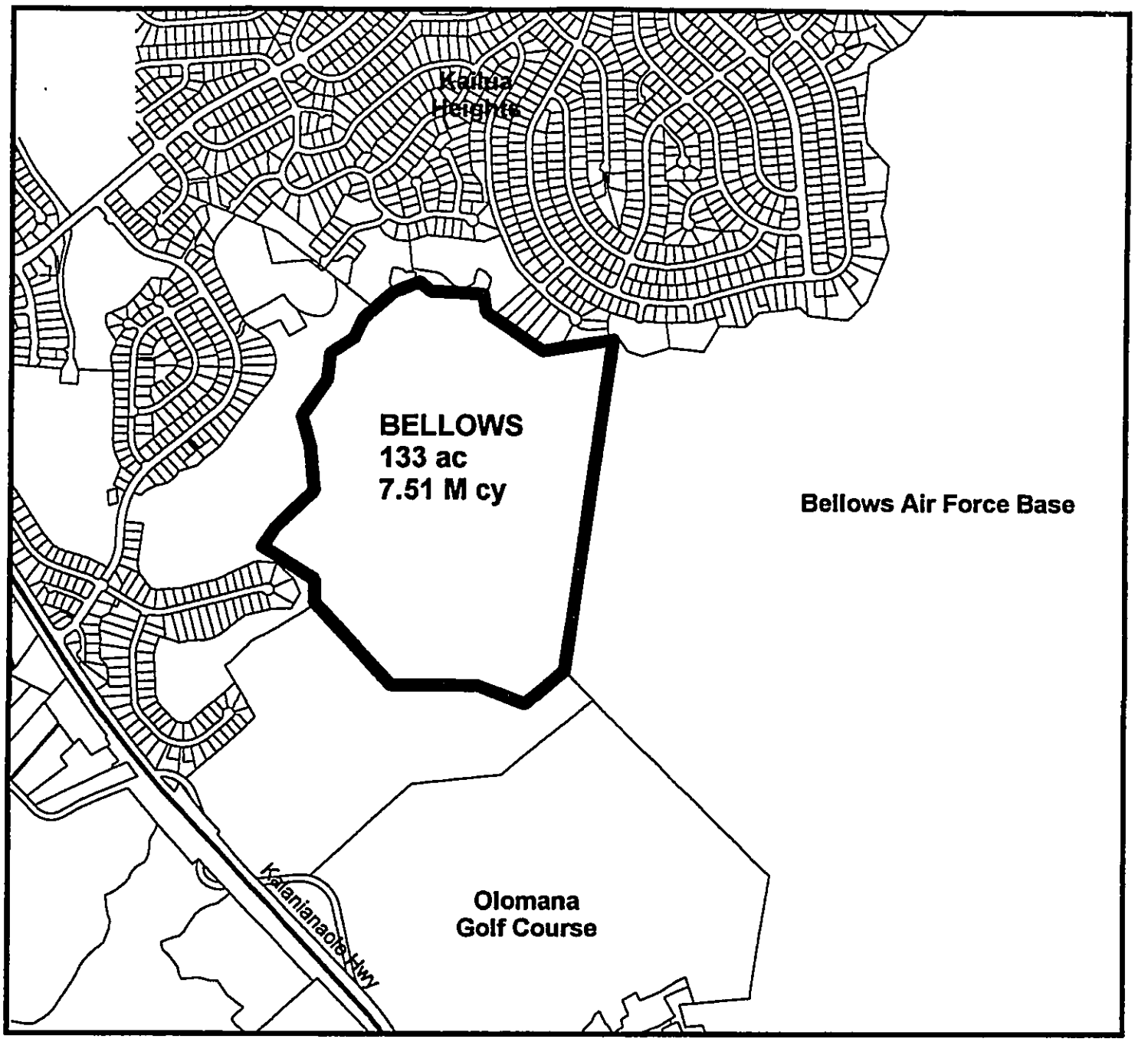
IDS Maps 1998, C & C Honolulu

3. **BELLOWS** - Located at the northern end of the Waimanalo residential community and Bellows Air Force Base in Windward Oahu. The site is relatively open but heavily vegetated in places. Elevation ranges from approximately 40 feet and rises to over 200 feet MSL. **(Figure 4-6).**

TMK:	4-1-15
Acreage:	±133 (±133 usable)
Ownership:	Federal Government (U.S. Military Reservation). Ownership of the site for military purposes would increase difficulty of land acquisition.
Adjoining Land Uses:	Within property of the U.S. Government. Immediately north is the Keolu Hills residential subdivision. To the west is Mount Olomana and immediately south, the Olomana Golf Course.
Cover Material:	Available on site
Soils Classification:	Alaeloa silty clay, 40 to 70% slopes Papaa clay, 6 to 20% slopes Papaa clay, 35 to 70% slopes Kawaihapai silty clay loam, 2 to 7% slopes
City and County of Honolulu Zoning:	P-1/F-1
State Land Use District:	Conservation
Capacity:	7.51 million cubic yards
Lifespan:	±12.5 years (based on 0.6 million cubic yards per year required)



LEGEND

▬▬▬	Site Boundary
OUTSIDE	Underground Infiltration Control (UIC) Line
OUTSIDE	Groundwater Protection Zone (GPZ) Line

FIGURE 4-6
Bellows

0 500 1000 1500 2000 FEET

Alternatives Analysis for Disposal of Municipal Solid Waste (MSW)
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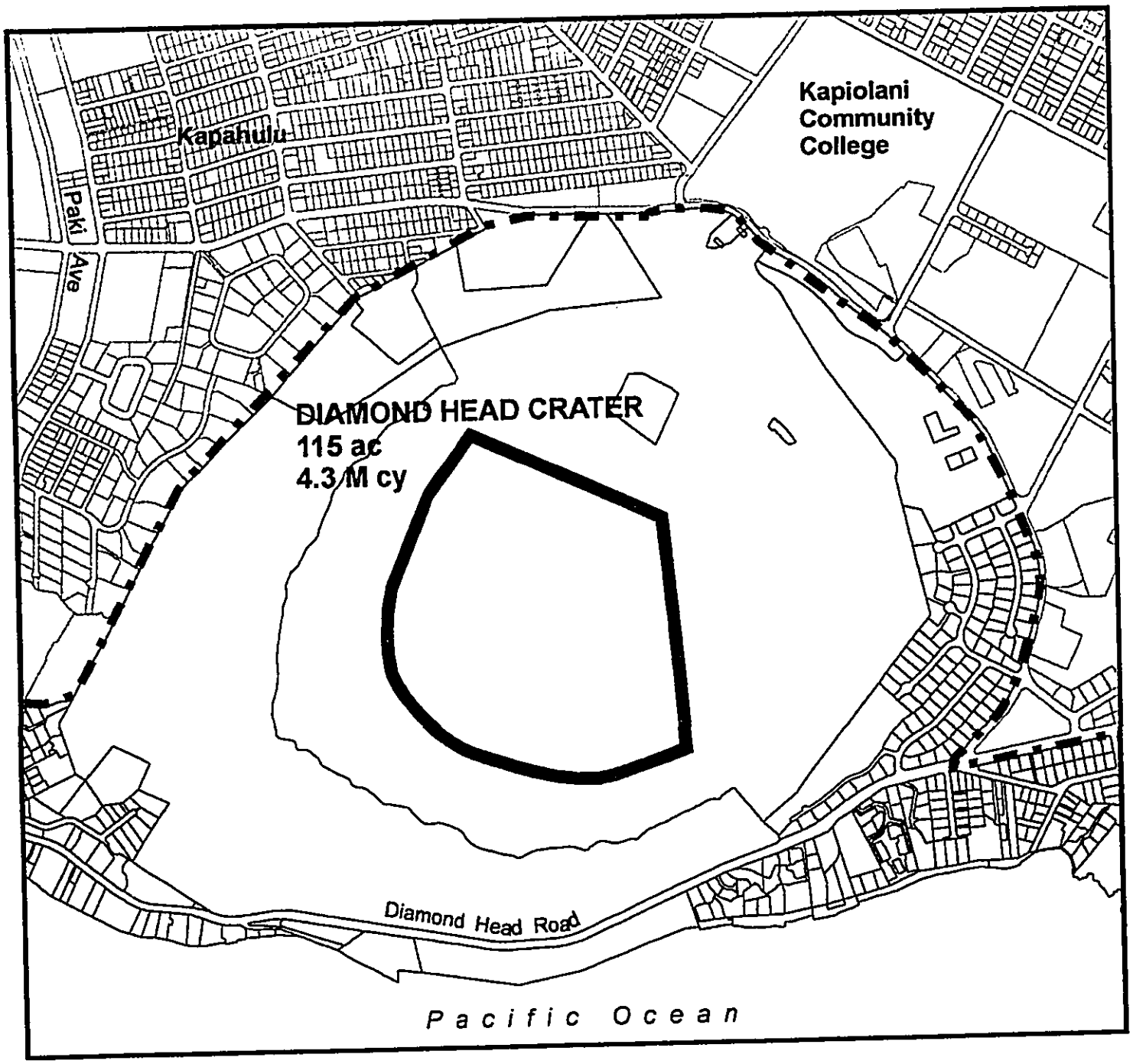
* Source: C & C Honolulu, ENV 2001
IDS Maps 1998, C & C Honolulu

4. DIAMOND HEAD CRATER - Located on the southwest end of the island of Oahu. The site is designated a State Monument and Natural Landmark. Elevation of the site ranges from approximately 120 feet to +160 feet MSL. (**Figure 4-7**).

TMK:	3-1-42:por 6
Acreage:	±115
Ownership:	State of Hawaii. Designation of the site as a State Monument and Natural Landmark would increase difficulty of site acquisition.
Adjoining Land Uses:	This location is immediately in proximity to urbanized areas of Diamond Head, Kahala, Waikiki, and Kapahulu. The Hawaii Army National Guard is a current tenant at this facility. Future uses by the State including park facility upgrades also indicate a long term desire to preserve the site.
Cover Material:	Must be imported
Soils Classification:	Makalapa clay, 6 to 12% slopes Makalapa clay, 12 to 20% slopes
City and County of Honolulu Zoning:	P-1
State Land Use District:	Conservation
Capacity:	4.3 million cubic yards
Lifespan:	± 7.2 years (based on 0.6 million cubic yards per year required)



LEGEND

▬▬▬	Site Boundary
▬ ▪ ▬ ▪ ▬	Underground Infiltration Control (UIC) Line
OUTSIDE	Groundwater Protection Zone (GPZ) Line

FIGURE 4-7
Diamond Head

0 500 1000 1500 2000 FEET

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Waste Management of Hawaii, Inc.

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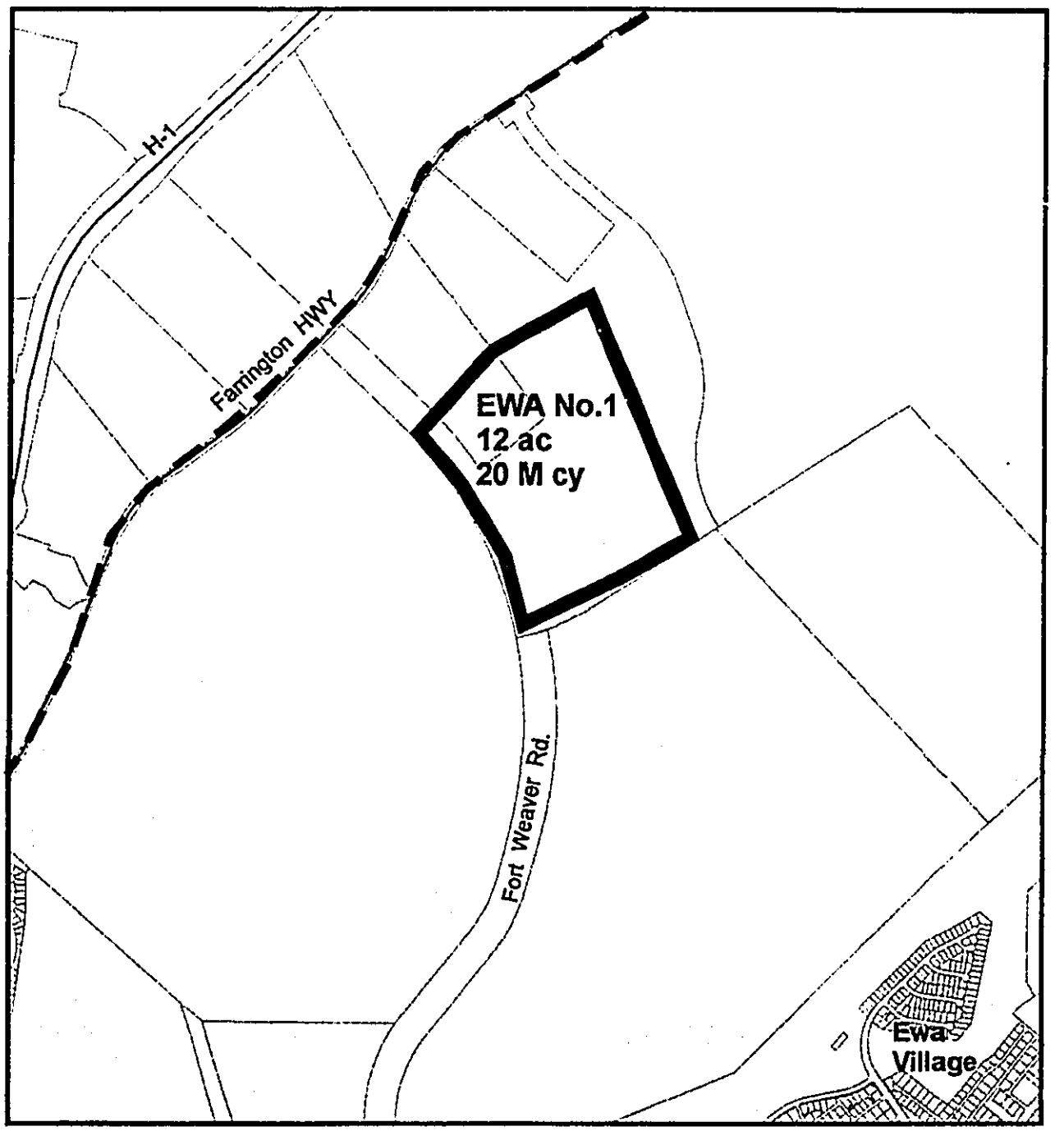
• Source: C & C Honolulu, ENV 2001
IDS Maps 1998, C & C Honolulu

5. EWA NO. 1 - This site is no longer viable due to residential development. The identification of this site is provided in **Figure 4-8.**



LGEND

▬▬▬	Site Boundary
INSIDE	Underground Infiltration Control (UIC) Line
- — - —	Groundwater Protection Zone (GPZ) Line

FIGURE 4-8
Ewa No. 1

0 500 1000 1500 2000 2500 3000 FEET

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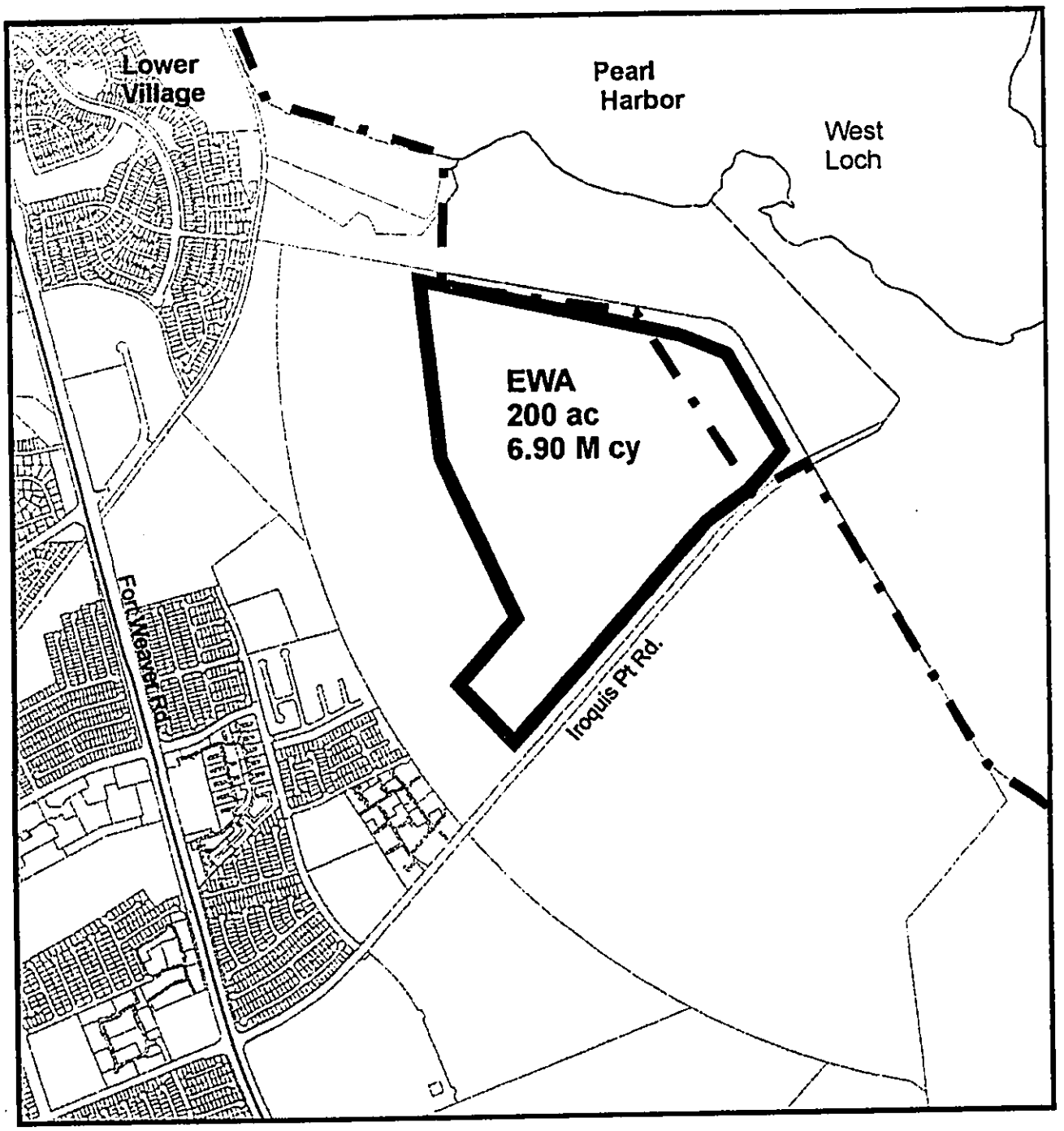
* Source: C & C Honolulu, ENV 2001
IDS Maps 1998, C & C Honolulu

6. EWA NO. 2 - This site is no longer viable due to residential development. The identification of this site is provided in **Figure 4-9.**



LEGEND

▬▬▬	Site Boundary
▬ ▪ ▬ ▪ ▬	Underground Infiltration Control (UIC) Line
OUTSIDE	Groundwater Protection Zone (GPZ) Line

FIGURE 4-9
Ewa No. 2

0 500 1000 1500 2000 2500 3000 FEET

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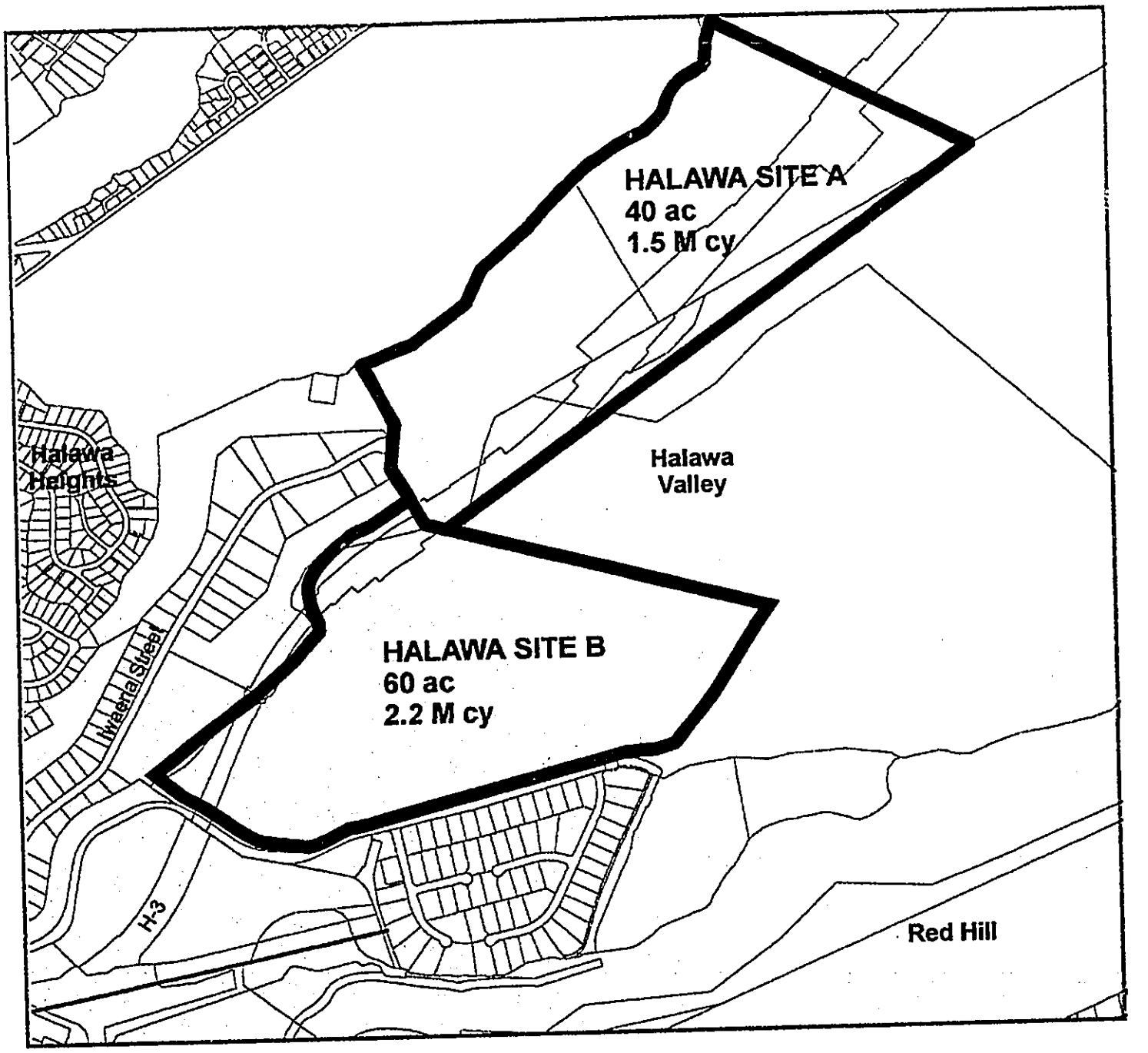
• Source: C & C Honolulu, ENV 2001
IDS Maps 1998, C & C Honolulu

7. **HALAWA SITE A** - Both Halawa Sites A and B are located in Halawa, mauka of the Moanalua Freeway and east of the H-3 Freeway. Halawa Site A is located in North Halawa Valley above the Halawa Industrial Park. Elevation ranges from approximately 200 feet to +600 feet MSL. **(Figure 4-10A).**

TMK:	9-9-10:8, 9, por 10 & 26
Acreage:	±40
Ownership:	City and County of Honolulu
Adjoining Land Uses:	Halawa Industrial Park and Halawa Quarry. Camp Smith Military Reservation is located west, and the Halawa Residential Subdivision is located west and to the south of Camp Smith. Halawa A adjoins the H-3 Freeway.
Cover Material:	Available on site
Soils Classification:	Kaena very stony clay, 10 to 35% slopes Manana silty clay, 8 to 15% slopes Rock land
City and County of Honolulu Zoning:	P-1
State Land Use District:	Urban
Capacity: yards	1.5 million cubic
Lifespan:	± 2.5 years (based on 0.6 million cubic yards per year required)



LEGEND

▬▬▬	Site Boundary
OUTSIDE	Underground Infiltration Control (UIC) Line
OUTSIDE	Groundwater Protection Zone (GPZ) Line

FIGURE 4-10A
Halawa A & B

0 500 1000 1500 2000
FEET

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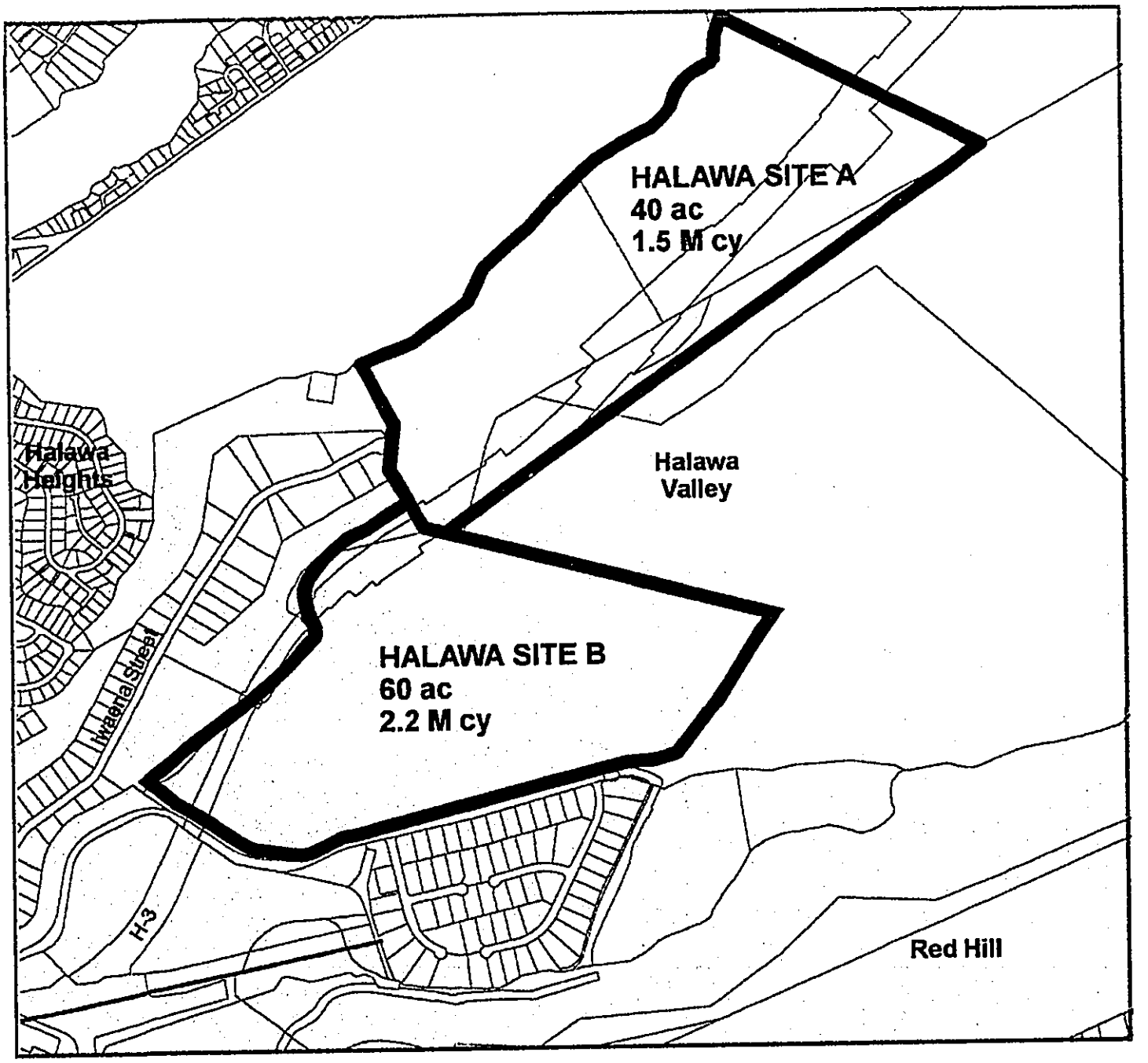
8. **HALAWA B** - Halawa B is located within the Halawa Quarry site. Elevation of this site ranges from approximately 120 feet to 360 feet MSL. **(Figure 4-10B).**

TMK:	9-9-10:27 & por 10
Acreage:	±60
Ownership:	Queen Emma Foundation
Adjoining Land Uses:	The project site is within portions of the Halawa Quarry. Camp Smith Military Reservation is located west, and the Halawa Residential Subdivision is located west and to the south of Camp Smith. The H-3 Freeway adjoins this site to the west.
Cover Material:	Available on site
Soils Classification:	Rock land Kawaihapai clay loam, 2 to 6% slopes
City and County of Honolulu Zoning:	P-1
State Land Use District:	
Capacity:	2.2 million cubic yards
Lifespan:	± 3.7 years (based on 0.6 million cubic yards per year required)



LEGEND

▬▬▬	Site Boundary
OUTSIDE	Underground Infiltration Control (UIC) Line
OUTSIDE	Groundwater Protection Zone (GPZ) Line

FIGURE 4-10B
Halawa A & B

0 500 1000 1500 2000 FEET

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* Source: C & C Honolulu, ENV 2001
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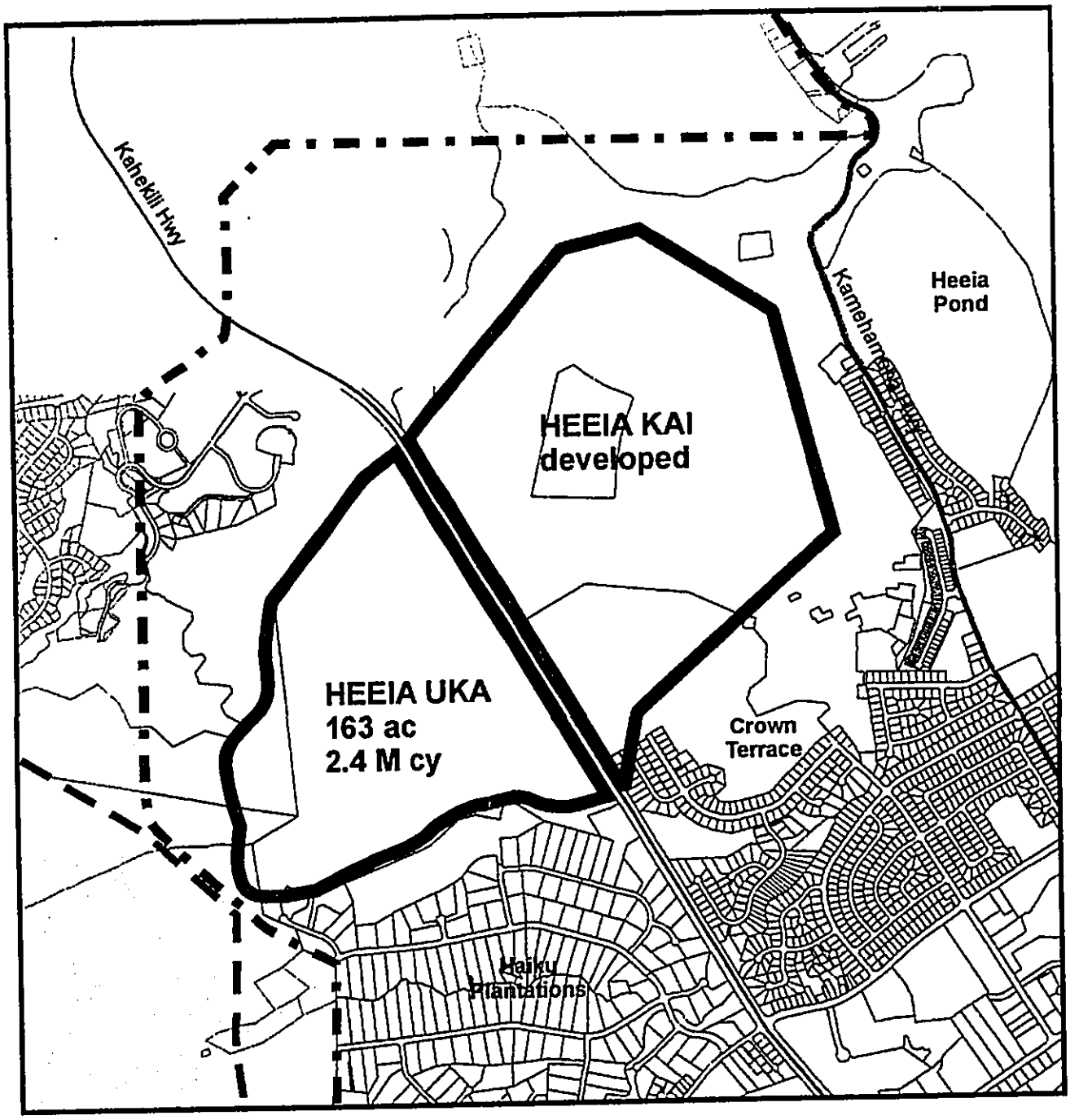
9. **HEEIA KAI** - This site is no longer viable due to residential development. The identification of this site is provided in **Figure 4-11.**

10. **HEEIA UKA** - This is site is located mauka on Kahekili Highway, approximately 2 miles north of the intersection of Kahekili Highway and Likelike Highway. Elevation ranges from approximately 40 feet to 360 feet MSL. **(Figure 4-11).**

TMK:	4-6-14:1
Acreage:	±163 (±50 usable)
Ownership:	Estate of Bernice P. Bishop
Adjoining Land Uses:	Immediately west is the Ahuimanu residential community. To the east is residential housing which extends as part of Kaneohe Town. Further to the west and south is Windward Community College.
Cover Material:	Available on site
Soils Classification:	Waikane silty clay, 25 to 40% slopes
City and County of Honolulu Zoning:	P-1
State Land Use District:	Conservation
Capacity:	2.4 million cubic yards
Lifespan:	± 4.0 years (based on 0.6 million cubic yards per year required)



Site Boundary

Underground Infiltration Control (UIC) Line

Groundwater Protection Zone (GPZ) Line

FIGURE 4-11
HeeiaKai & HeeiaUka

0 500 1000 1500 2000 2500 3000 FEET

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• Source: C & C Honolulu, ENV 2001
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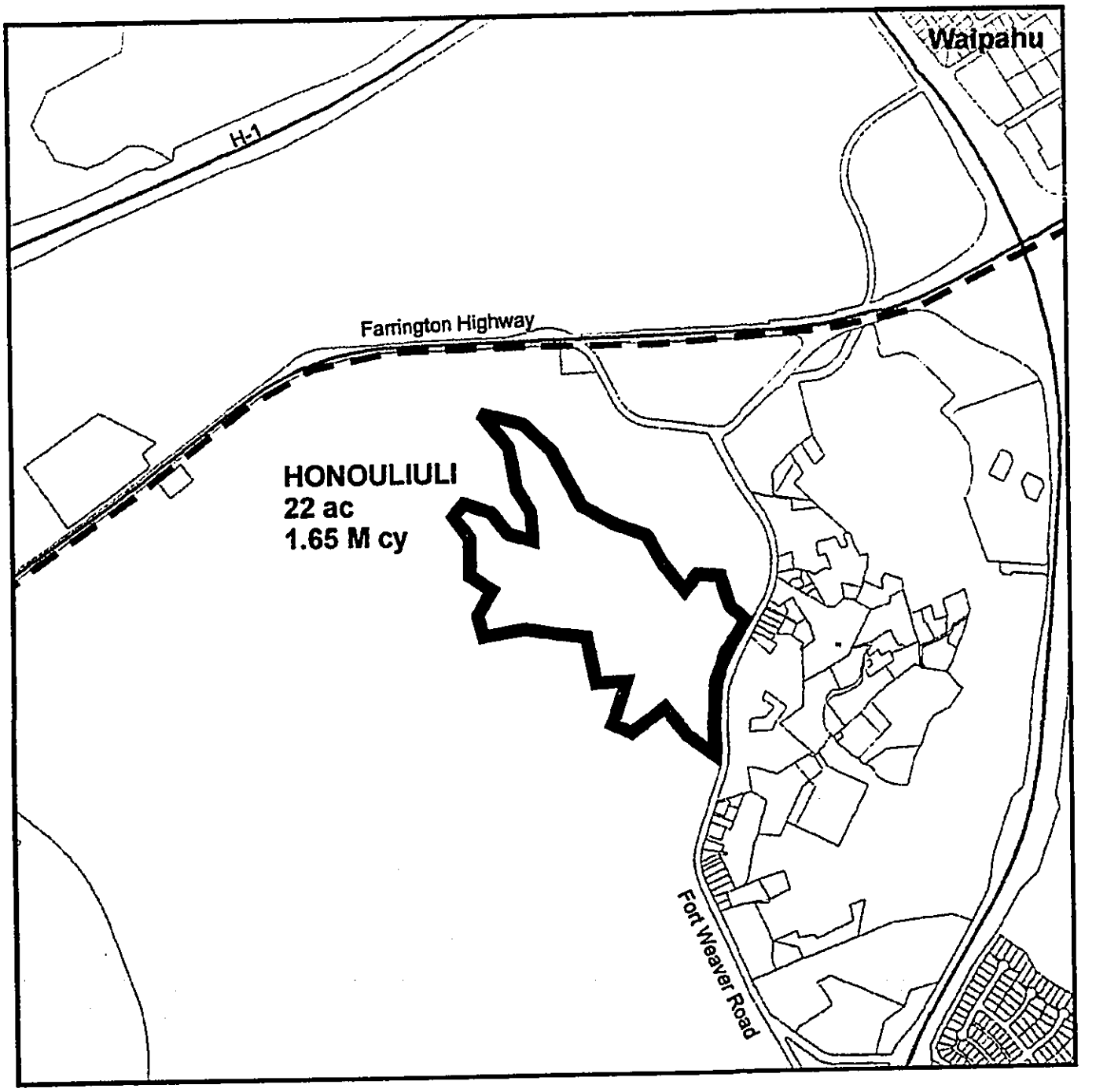
11. **HONOULIULI** - This site is located approximately 2.6 miles east of Puu Makakilo, a half mile south of Farrington Highway which roughly adjoins the site, 2.4 miles east-southeast of Puu Kapuai and 4.5 miles north-northwest of Ewa Beach. Elevation of the site ranges from approximately 40 feet to 120 feet MSL. **(Figure 4-12).**

TMK:	9-1-17:por 4
Acreage:	±22
Ownership:	Estate of James Campbell
Adjoining Land Uses:	This site adjoins Fort Weaver Road and the town of Ewa to the west and to the south. The Waikele residential subdivision lies northwest.
Cover Material:	Available on site
Soils Classification:	Waialua silty clay, 0 to 8% slopes Helemano silty clay, 30 to 90% slopes
City and County of Honolulu Zoning:	Ag-1
State Land Use District:	Agricultural
Capacity:	1.65 million cubic yards
Lifespan:	± 2.8 years (based on 0.6 million cubic yards per year required)



LEGEND

▬▬▬	Site Boundary
INSIDE	Underground Infiltration Control (UIC) Line
- - - -	Groundwater Protection Zone (GPZ) Line

FIGURE 4-12
Honouliuli

0 500 1000 1500 2000 FEET

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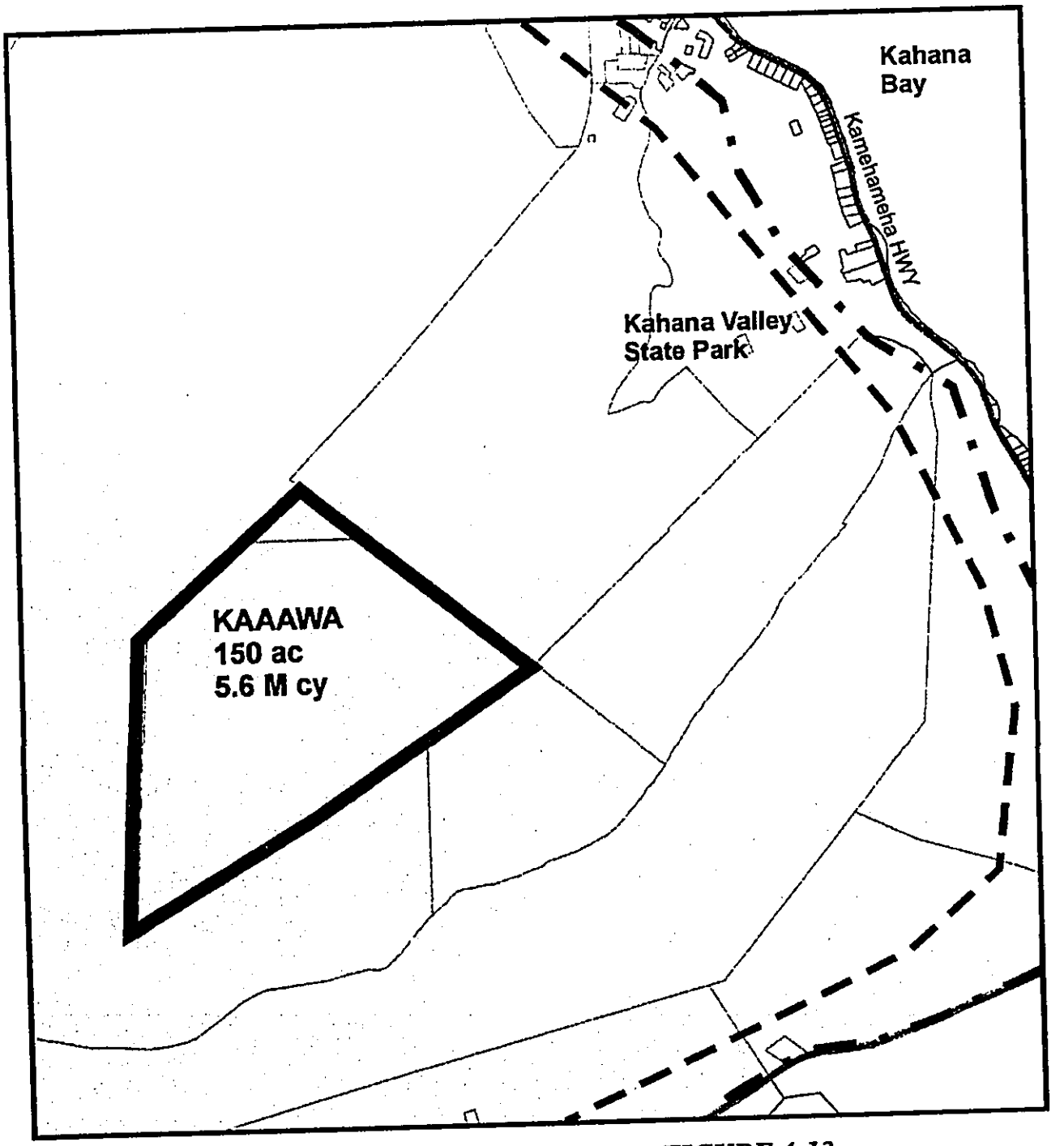
12. **KAAAWA** - The town of Kaaawa lies to the north of the site. Further south are the districts of Kualoa and Waikane. Elevation of the site ranges from approximately 120 feet to 360 MSL. **(Figure 4-13).**

TMK:	5-1
Acreage:	±150
Ownership:	To be determined based on site boundary
Adjoining Land Uses:	Most of the area surrounding this site is either in agriculture or in preservation and open space.
Cover Material:	Cover material is anticipated to be available on site
Soils Classification:	Lolekaa silty clay, 3 to 8% slopes Lolekaa silty clay, 8 to 15% slopes Lolekaa silty clay, 40 to 70% slopes
City and County of Honolulu Zoning:	Ag-2
State Land Use District:	Conservation and Agriculture
Capacity:	5.6 million cubic yards
Lifespan:	±9.3 years (based on 0.6 million cubic yards per year required)



LEGEND

- Site Boundary
- Underground Infiltration Control (UIC) Line
- Groundwater Protection Zone (GPZ) Line

FIGURE 4-13
Kaaawa

0 500 1000 1500 2000 2500 3000 FEET

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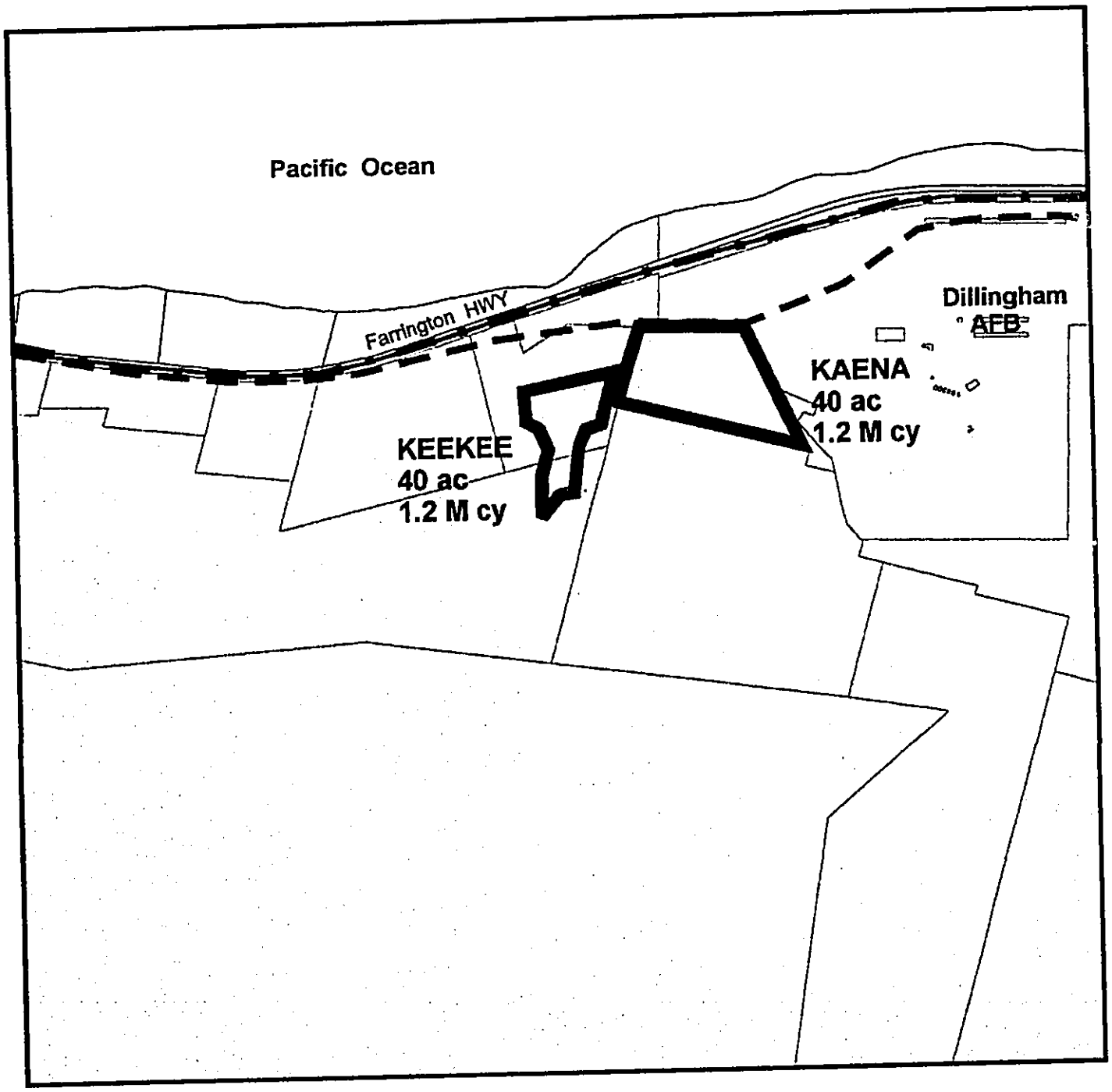
13. KAENA - This site is located at the west mauka end of the Dillingham Air Force Base, 1,000 feet mauka of Farrington Highway and 6 miles west of the town of Waialua, North Shore, Oahu. Elevation ranges from approximately 80 to 700 feet MSL. **(Figure 4-14A).**

TMK:	6-9-1:por 3, 33 and 34
Acreage:	±40 (±20 usable)
Ownership:	State of Hawaii and Dillingham Corporation
Adjoining Land Uses:	Portions of the site were once used for quarrying operations. Dillingham AFB is located immediately to the west and the Pacific Ocean shoreline is located approximately 2,000 feet north.
Cover Material:	Available on site
Soils Classification:	Rock land Pulehu clay loam, 0 to 3% slopes
City and County of Honolulu Zoning:	P-1
State Land Use District:	Conservation
Capacity:	1.5 million cubic yards
Lifespan:	±2.5 years (based on 0.6 million cubic yards per year required)



LEGEND

- Site Boundary
- Underground Infiltration Control (UIC) Line
- Groundwater Protection Zone (GPZ) Line

FIGURE 4-14A
Kaena & Keekee

0 500 1000 1500 2000 FEET

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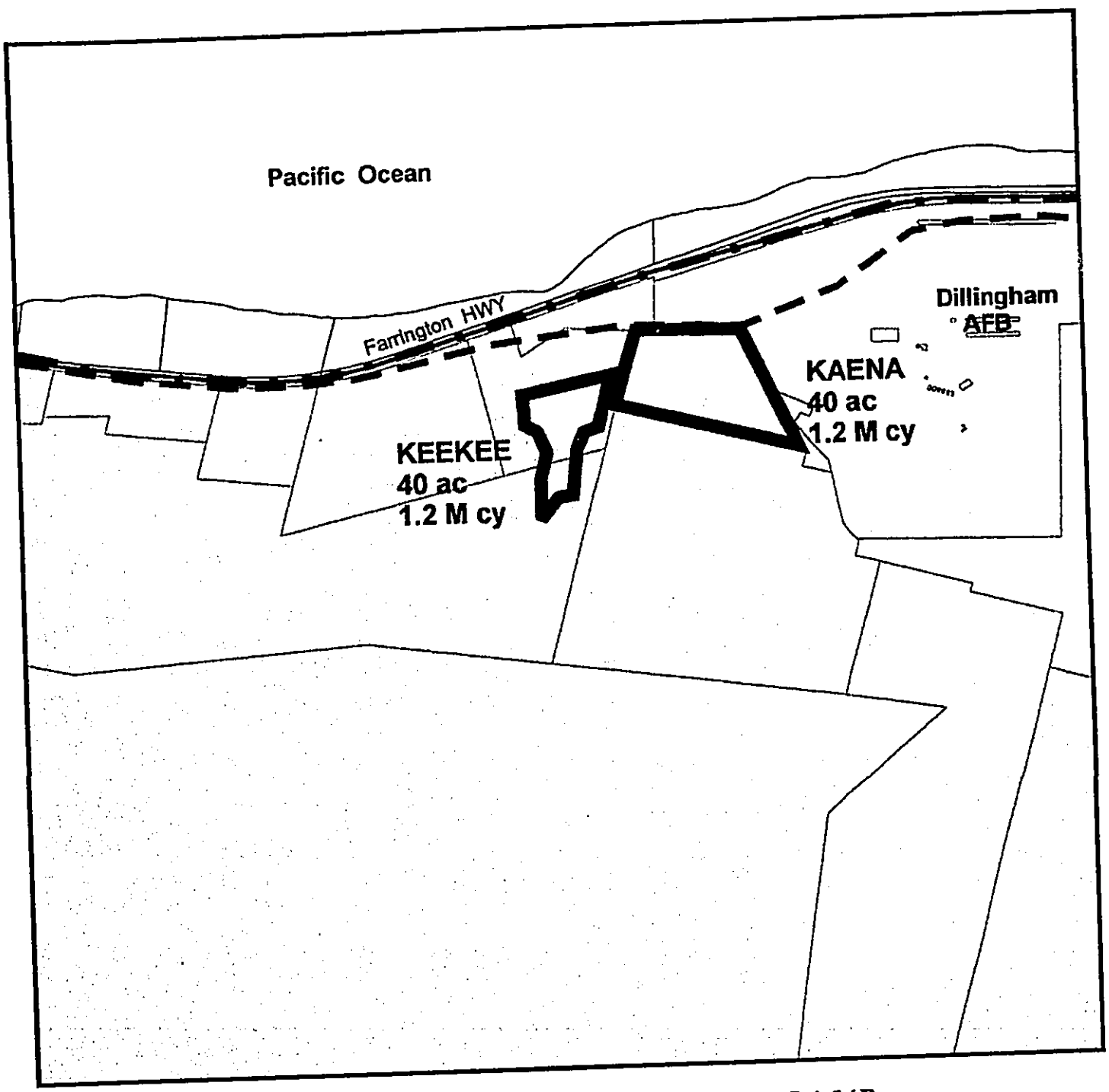
14. **KEEKEE** - This site is adjacent to and west of the Kaena site. The site adjoins Farrington Highway in the North Shore of Oahu. Elevation ranges from approximately 20 feet to over 300 feet MSL. (**Figure 4-14B**).

TMK:	6-9-1:por 3 & 4 6-9-3:por 2
Acreage:	±115
Ownership:	State of Hawaii, Lucky S. Dairy
Adjoining Land Uses:	Site is located next to the Kaena Site. Coastal waters of the Pacific Ocean are located immediately north and Dillingham Air Force Base is located east of the site.
Cover Material:	Available on site
Soils Classification:	Rock land Pulehu clay loam, 0 to 3% slopes Stony steep land
City and County of Honolulu Zoning:	P-1
State Land Use District:	Agricultural
Capacity:	1.2 million cubic yards
Lifespan:	±2 years (based on 0.6 million cubic yards per year required)



LEGEND

- Site Boundary
- Underground Infiltration Control (UIC) Line
- Groundwater Protection Zone (GPZ) Line

FIGURE 4-14B
Kaena & Keekee

0 500 1000 1500 2000 FEET

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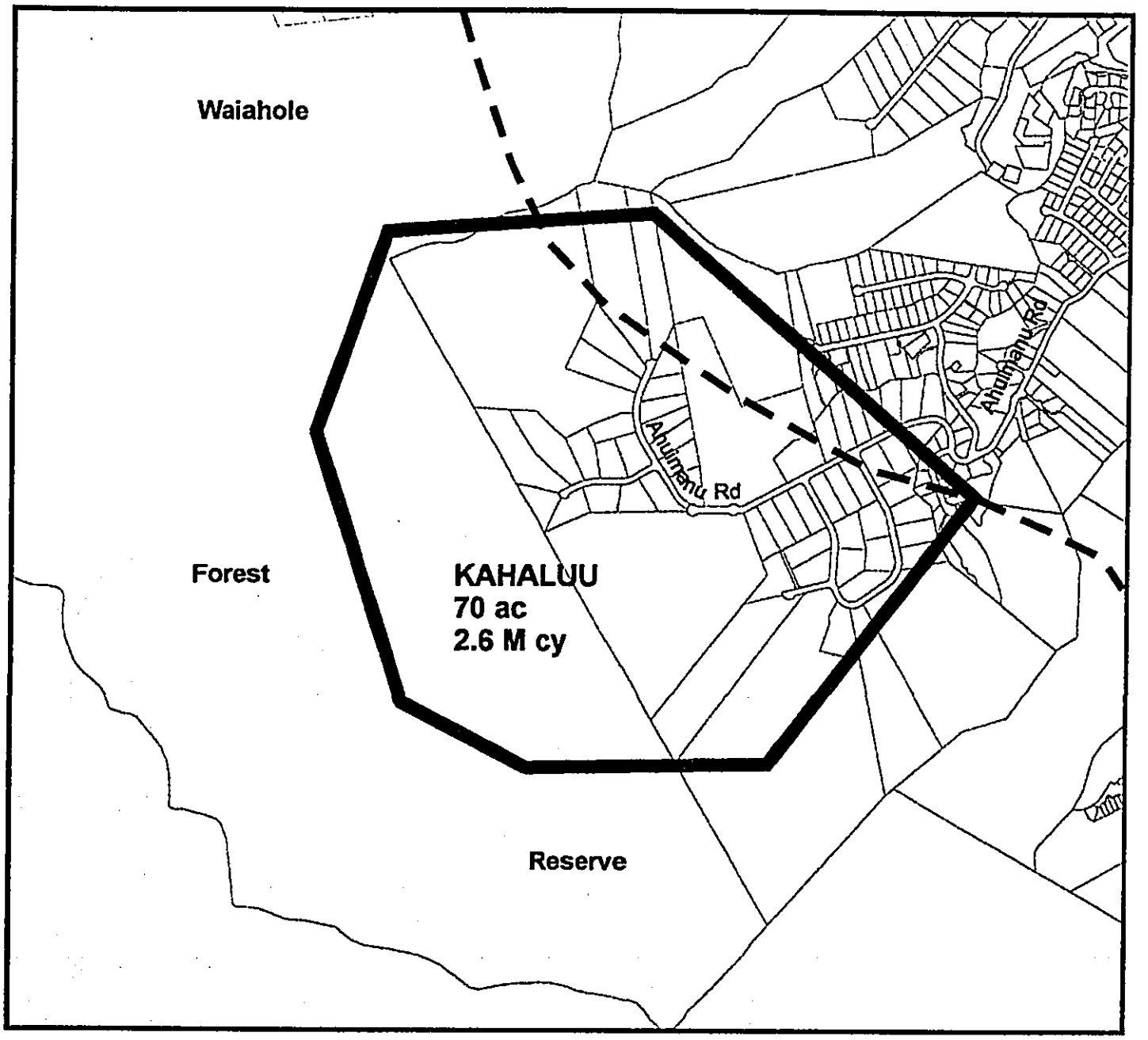
15. **KAHALUU** - This site is no longer viable due to residential development. The identification of this site is provided in **Figure 4-15.**



LEGEND

▬▬▬	Site Boundary
INSIDE	Underground Infiltration Control (UIC) Line
- - - -	Groundwater Protection Zone (GPZ) Line

FIGURE 4-15
Kahaluu

0 500 1000 1500 2000 FEET

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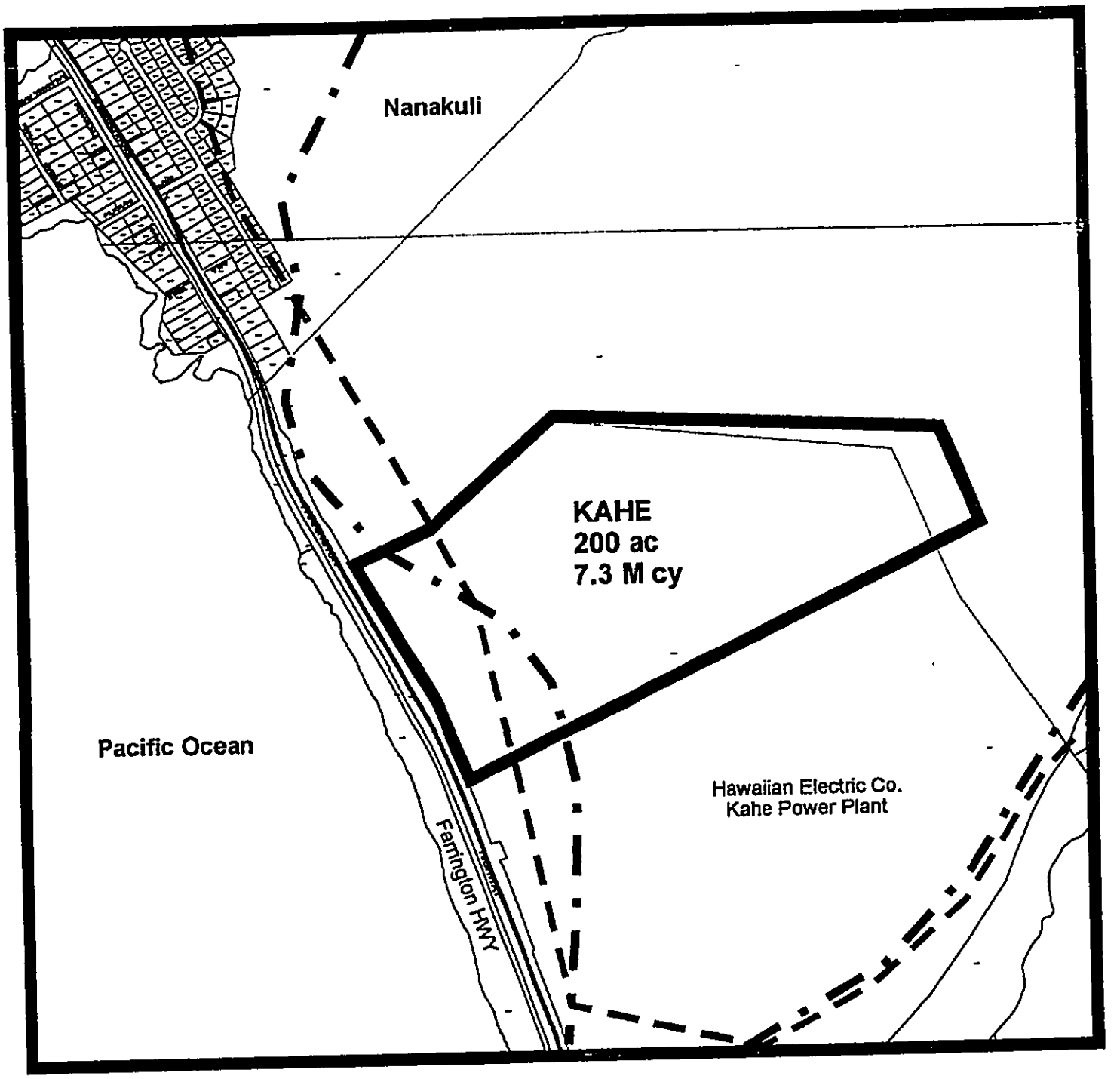
16. **KAHE** - This site is located adjacent to and west of the HECO power generating station located in Leeward Oahu. Coastal waters of the Pacific Ocean are located approximately 500 feet southwest of the site. Elevation ranges from approximately 40 feet to over 800 feet MSL. **(Figure 4-16).**

TMK:	3-1-42:por 6
Acreage:	±200
Ownership:	State of Hawaii
Adjoining Land Uses:	Immediately west of the site is the HECO power generating station. Single family residences of Nanakuli are located further north of the site beyond Pili O Kahe Gulch. To the south is the Kahe Point Beach Park.
Cover Material:	Cover material is anticipated to be available on site
Soils Classification:	Stony steep land Rock land
City and County of Honolulu Zoning:	I-2 and P-1
State Land Use District:	Agricultural and Urban
Capacity:	7.4 million cubic yards
Lifespan:	±12.3 years (based on 0.6 million cubic yards per year required)



LEGEND

- Site Boundary
- Underground Infiltration Control (UIC) Line
- Groundwater Protection Zone (GPZ) Line

FIGURE 4-16
Kahe

0 500 1000 1500 2000 FEET

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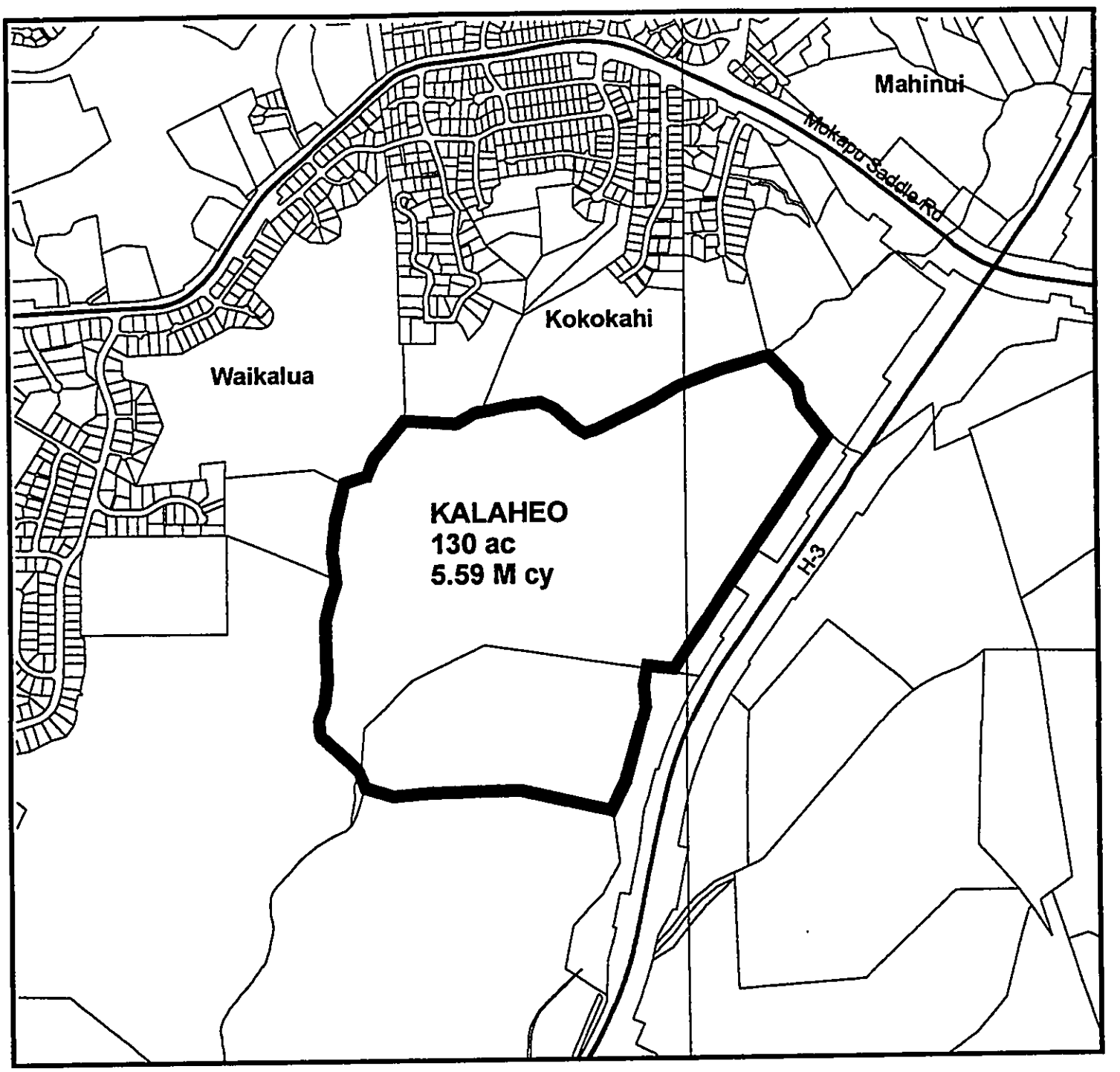
17. KALAHEO - This site is located west of the H-3 Freeway and Kawainui Marsh, north of Kapaa Quarry, and south of Mokapu Saddle Road in Kailua. The site is approximately 2,000 feet northwest of the Kapaa Landfill. Elevation of the site ranges from approximately 80 to +600 feet MSL. **(Figure 4-17).**

This site was used as a City and County landfill and is now closed.



LEGEND

▬▬▬	Site Boundary
OUTSIDE	Underground Infiltration Control (UIC) Line
OUTSIDE	Groundwater Protection Zone (GPZ) Line

FIGURE 4-17
Halaheo

0 500 1000 1500 2000 FEET

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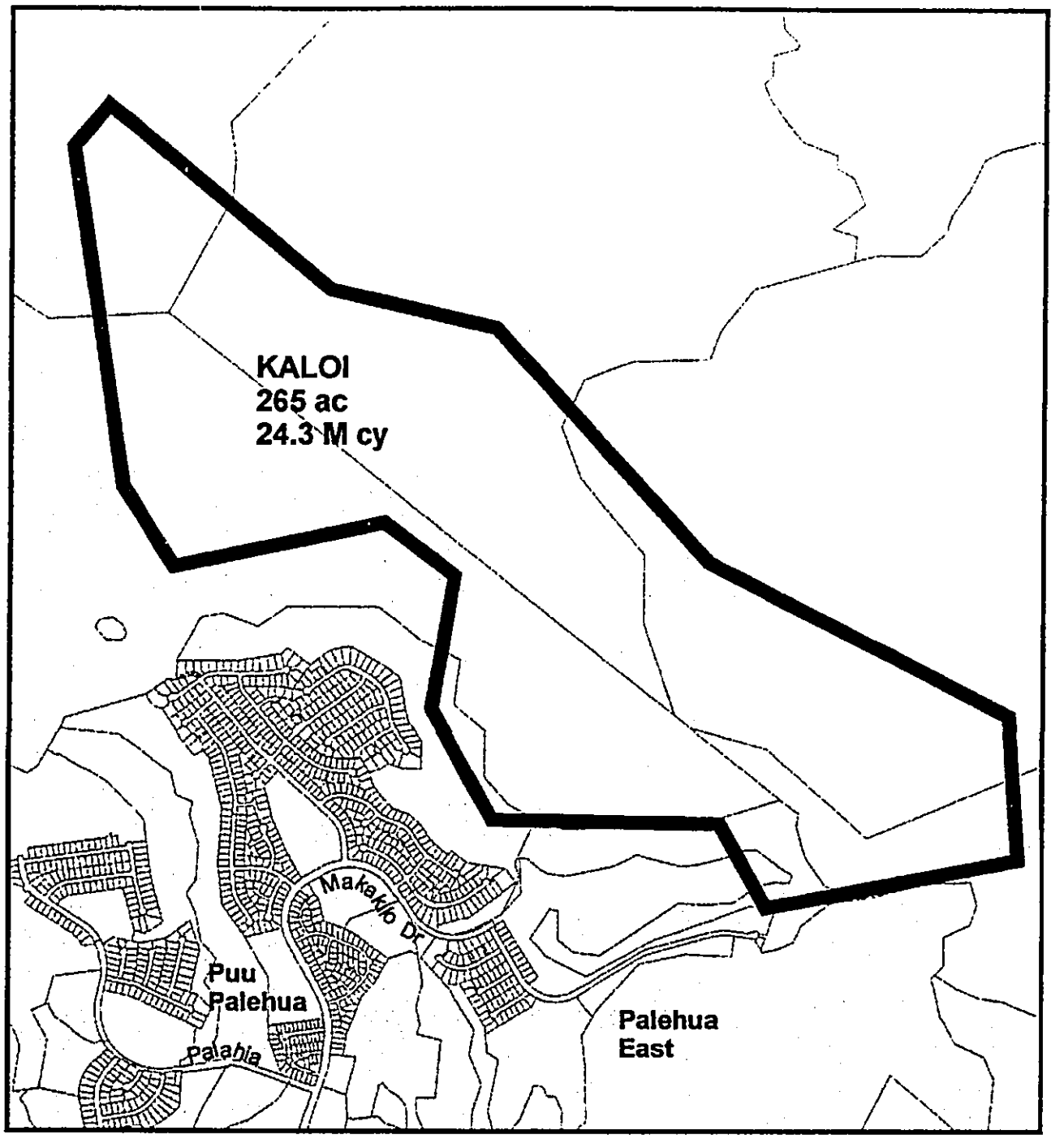
18. KALOI - Site is located south of Puu Kapuai and north of Puu Makakilo in Kaloi Gulch, Ewa. Elevation ranges from approximately 340 to +1300 feet MSL. **(Figure 4-18).**

TMK:	9-2-2: por 1 9-2-3:por 2 9-2-4:por 5
Acreage:	±400 (±265 usable)
Ownership:	Estate of James Campbell
Adjoining Land Uses:	Immediately southwest of the site is the Makakilo residential subdivision.
Cover Material:	Some available on site, imported cover necessary
Soils Classification:	Rock land Kawaihapai stony clay loam, 2 to 6% slopes Molokai silty clay loam, 15 to 25% slopes Helemano silty clay, 30 to 90% slopes Mahana badland complex
City and County of Honolulu Zoning:	Ag-1, Ag-2, and P-1
State Land Use District:	Agriculture
Capacity:	24.3 million cubic yards
Lifespan: required)	±40.5 years (based on 0.6 million cubic yards per year



LEGEND

▬▬▬	Site Boundary
INSIDE	Underground Infiltration Control (UIC) Line
INSIDE	Groundwater Protection Zone (GPZ) Line

FIGURE 4-18
Kaloi

0 500 1000 1500 2000 2500 3000 FEET

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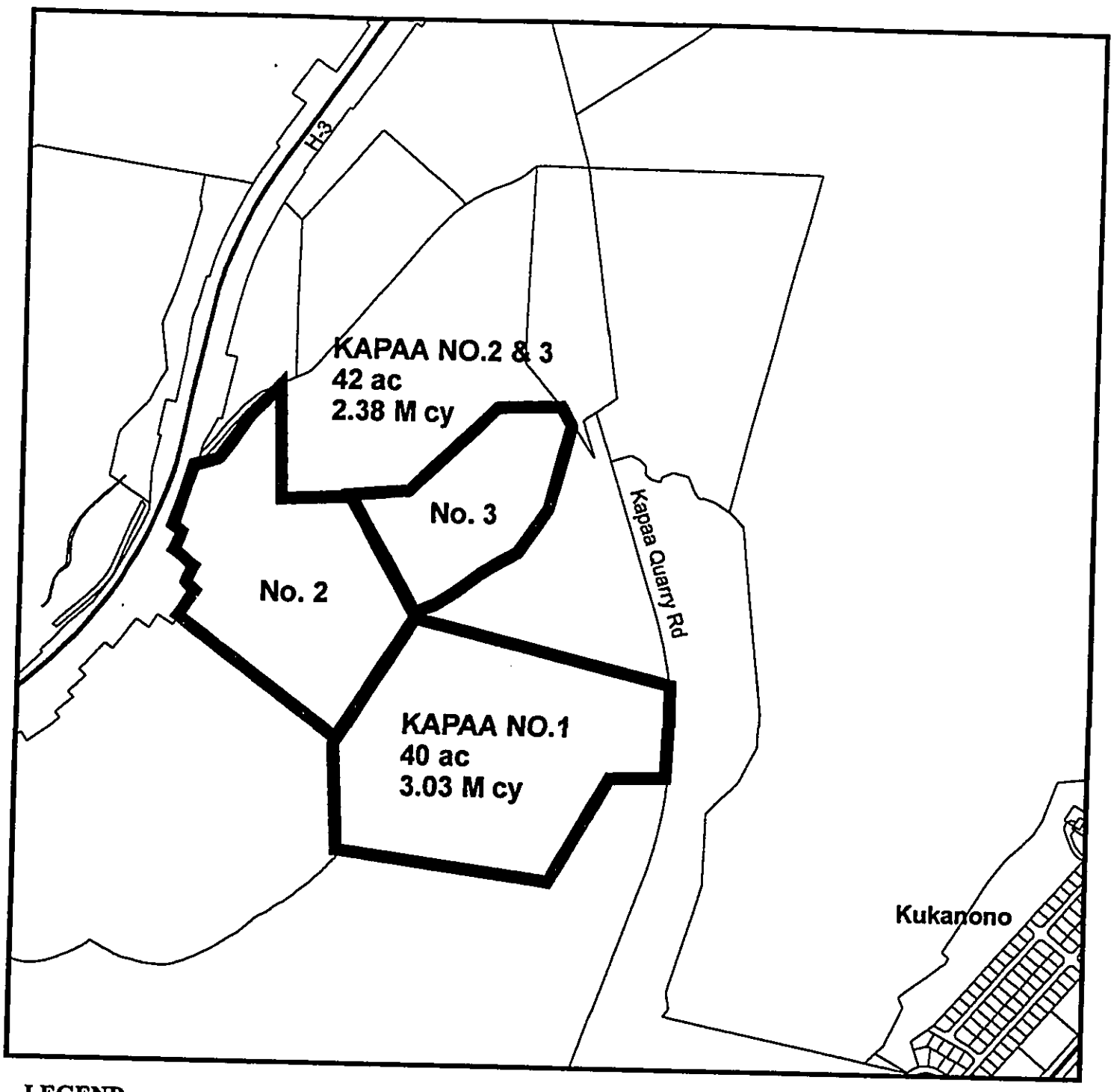
19. **KAPAA NO. 1** - This site is located west of Kapaa Quarry Road and Kawainui Marsh, and east of Ulumawao Peak in Kailua. Elevation ranges from approximately 70 to 500 feet MSL. **(Figure 4-19A).**

TMK:	4-4-14: por 2
Acreage:	±60 (±40 usable)
Ownership:	Lou Ellen Tomlinson
Adjoining Land Uses:	The site is approximately 1500 feet southeast of the closed Kapaa Landfill site. Further southeast of the site is the Castle Memorial Hospital, the Maunawili residential subdivision, and Le Jardin School.
Cover Material:	Available on site and from nearby Quarry.
Soils Classification:	Rock land Helemano silty clay, 30 to 90% slopes Alaeloa silty clay, 40 to 70% slopes Alaeloa silty clay, 15 to 35% slopes Kawaihapai clay loam, 6 to 15% slopes Kawaihapai stony clay loam, 2 to 6% slopes
City and County of Honolulu Zoning:	P-1
State Land Use District:	Conservation
Capacity:	3.03 million cubic yards
Lifespan:	±5.1 years (based on 0.6 million cubic yards per year required)



LEGEND

▬▬▬	Site Boundary
OUTSIDE	Underground Infiltration Control (UIC) Line
OUTSIDE	Groundwater Protection Zone (GPZ) Line

FIGURE 4-19A
KAPAA No. 1, 2 & 3

0 500 1000 1500 2000 FEET

Alternatives Analysis for Disposal of Municipal Solid Waste (MSW)

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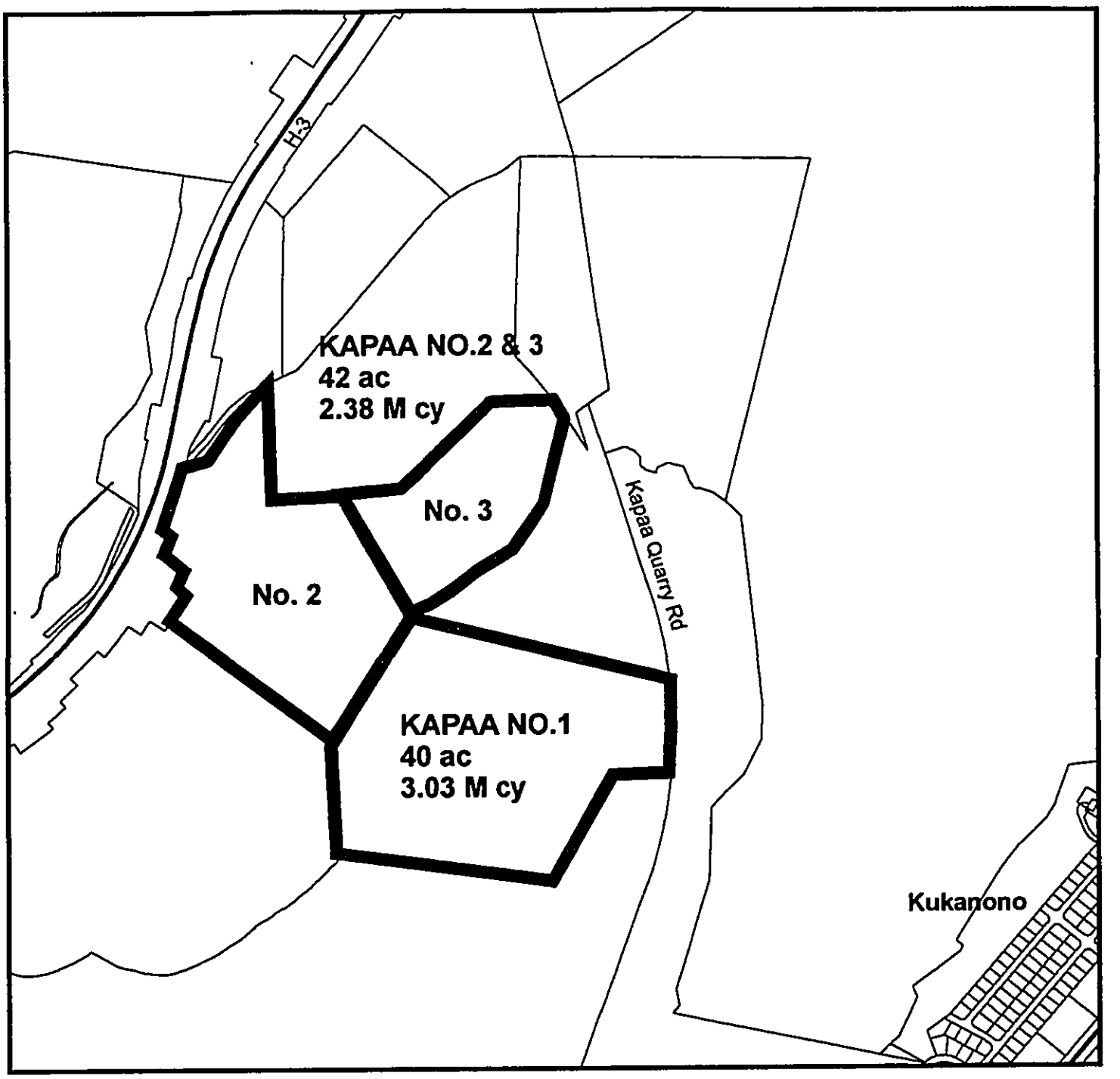
20. KAPAA NO. 2 & 3 - This site adjoins Kapaa No 1. Elevation ranges from approximately 120 feet to +400 MSL. **(Figure 4-19B).**

This site was once used for a City and County landfill, but is now closed.



LEGEND

▬▬▬	Site Boundary
OUTSIDE	Underground Infiltration Control (UIC) Line
OUTSIDE	Groundwater Protection Zone (GPZ) Line

FIGURE 4-19B
KAPAA No. 1, 2 & 3

0 500 1000 1500 2000 FEET

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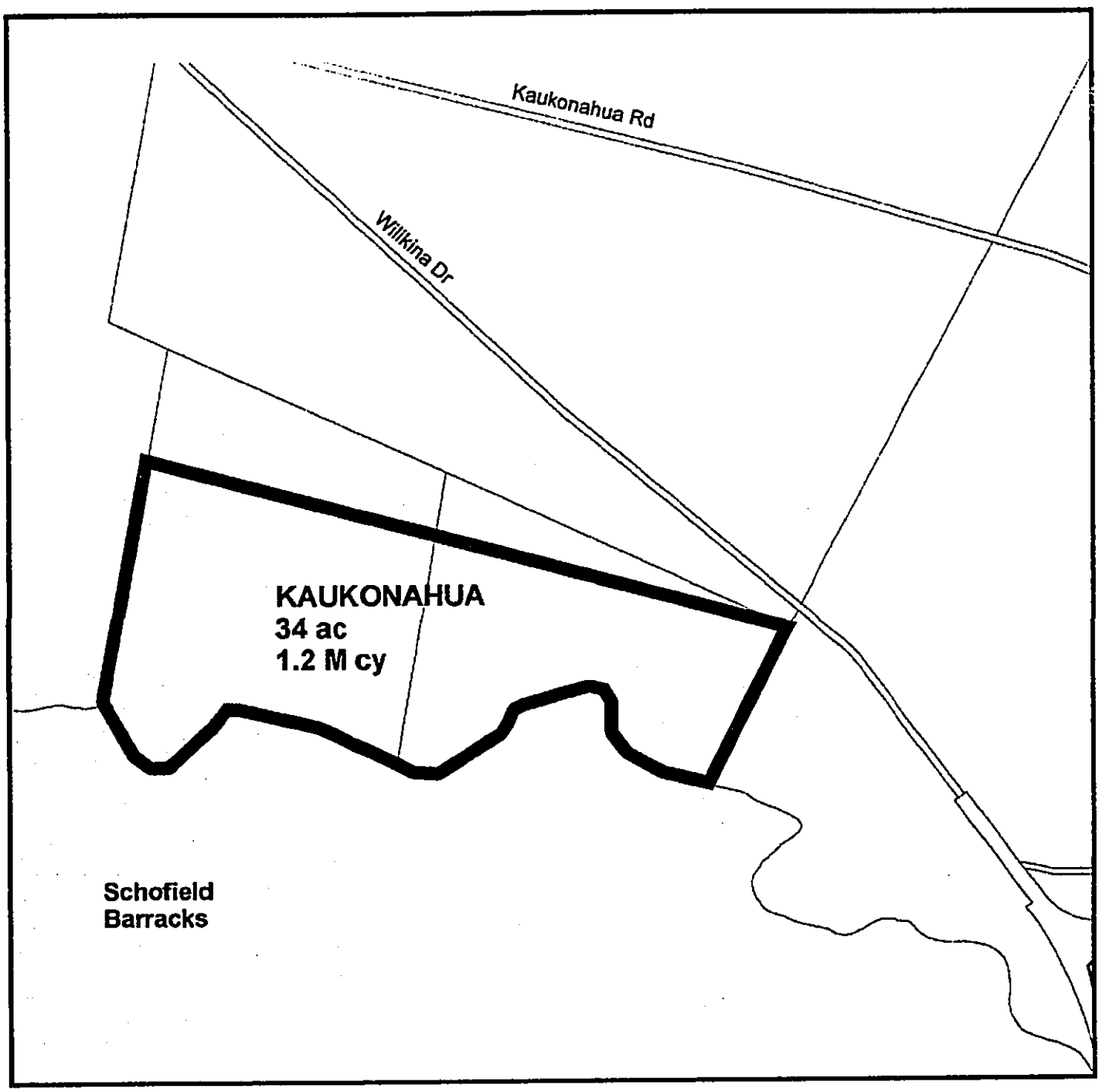
21. **KAUKONAHUA** - This site is located north of Schofield Barracks Military Reservation, adjacent to the town of Wahiawa in Central Oahu. Kaukonahua Road is located to the north. Elevation ranges from approximately 680 feet to 920 feet MSL. (**Figure 4-20**).

TMK:	7-1
Acreage:	±34
Ownership:	To be determined based on site boundary
Adjoining Land Uses:	Schofield Barracks Military Reservation is located immediately to the south. The area is primarily in agriculture and open space.
Cover Material:	Cover material is anticipated to be available on site
Soils Classification:	Helemano silty clay, 30 to 90% slopes Wahiawa silty clay, 3 to 8% slopes
City and County of Honolulu Zoning:	Ag-1
State Land Use District:	Agricultural
Capacity:	1.3 million cubic yards
Lifespan:	±2.2 years (based on 0.6 million cubic yards per year required)



LEGEND

▬▬▬	Site Boundary
INSIDE	Underground Infiltration Control (UIC) Line
INSIDE	Groundwater Protection Zone (GPZ) Line

FIGURE 4-20
Kaukonahua

0 500 1000 1500 2000 FEET

Alternatives Analysis for Disposal of Municipal Solid Waste (MSW)
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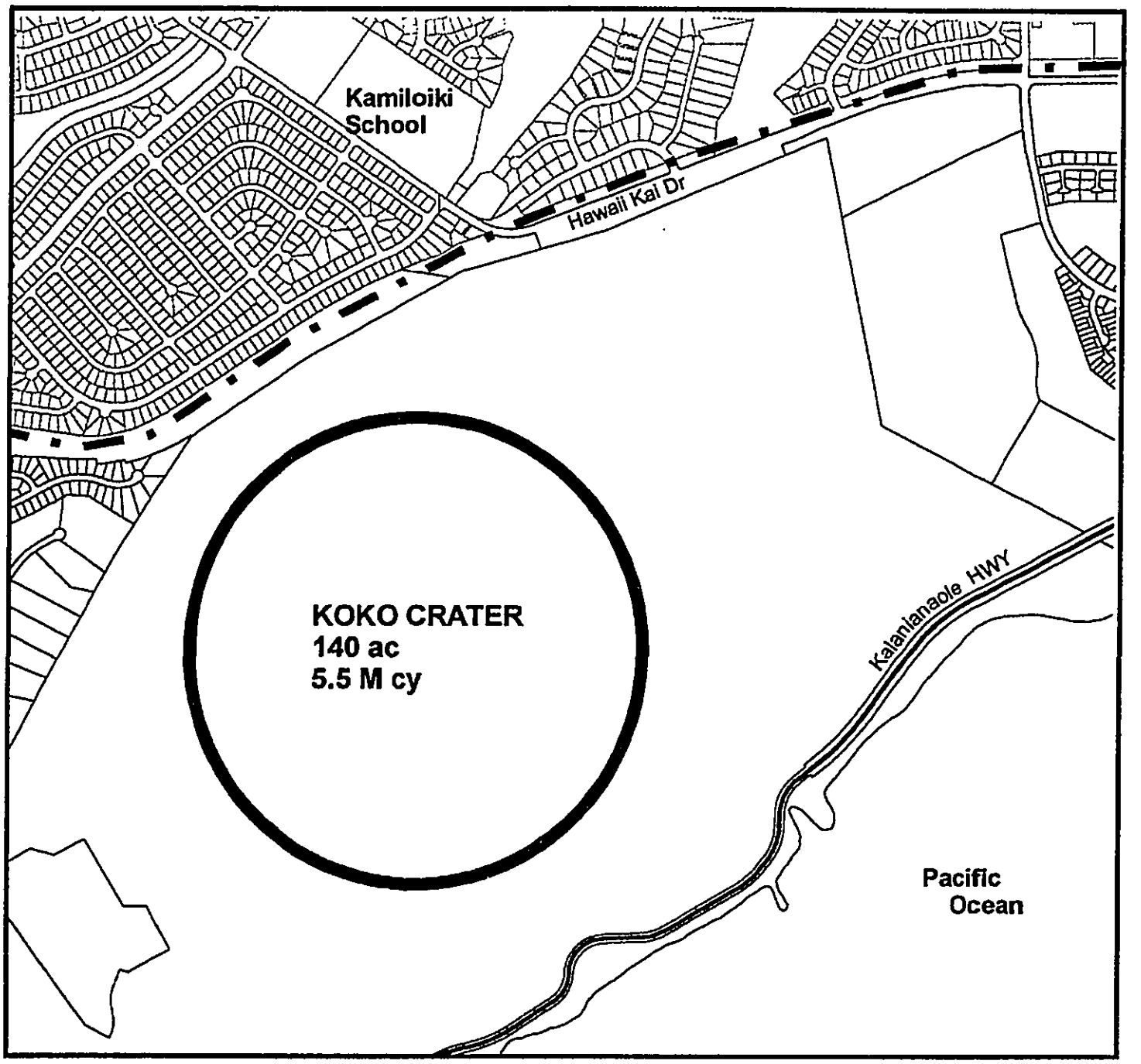
22. **KOKOHEAD CRATER** - This site is located at the southeastern tip of Oahu, 2.5 miles west-southwest of Makapuu Point, one mile east of Kuapa Pond, and 1.3 miles northwest of Hanauma Bay. Elevation of the site ranges from approximately 230 feet to 1,200 feet MSL. **(Figure 4-21).**

TMK:	3-19-12:por 1
Acreage:	±75
Ownership:	City and County of Honolulu. Use of the site as a designated park and regional landmark would increase difficulty of site acquisition for landfill use.
Adjoining Land Uses:	Land uses within the crater include a public park, and police and public firing range. A botanical garden occupies a small portion the crater. Hawaii Kai and Kalama Valley residential developments are located north and to the west of the site. Kaiser High School is located immediately west of the site.
Cover Material:	Must be imported
Soils Classification:	Koko silt loam, 6 to 12% slopes Rock land
City and County of Honolulu Zoning:	P-1
State Land Use District:	Conservation
Capacity:	5.5 million cubic yards
Lifespan:	±9.2 years (based on 0.6 million cubic yards per year required)



LEGEND

▬▬▬	Site Boundary
▬ ▪ ▬ ▪ ▬	Underground Infiltration Control (UIC) Line
OUTSIDE	Groundwater Protection Zone (GPZ) Line

FIGURE 4-21
Koko Crater

0 500 1000 1500 2000 FEET

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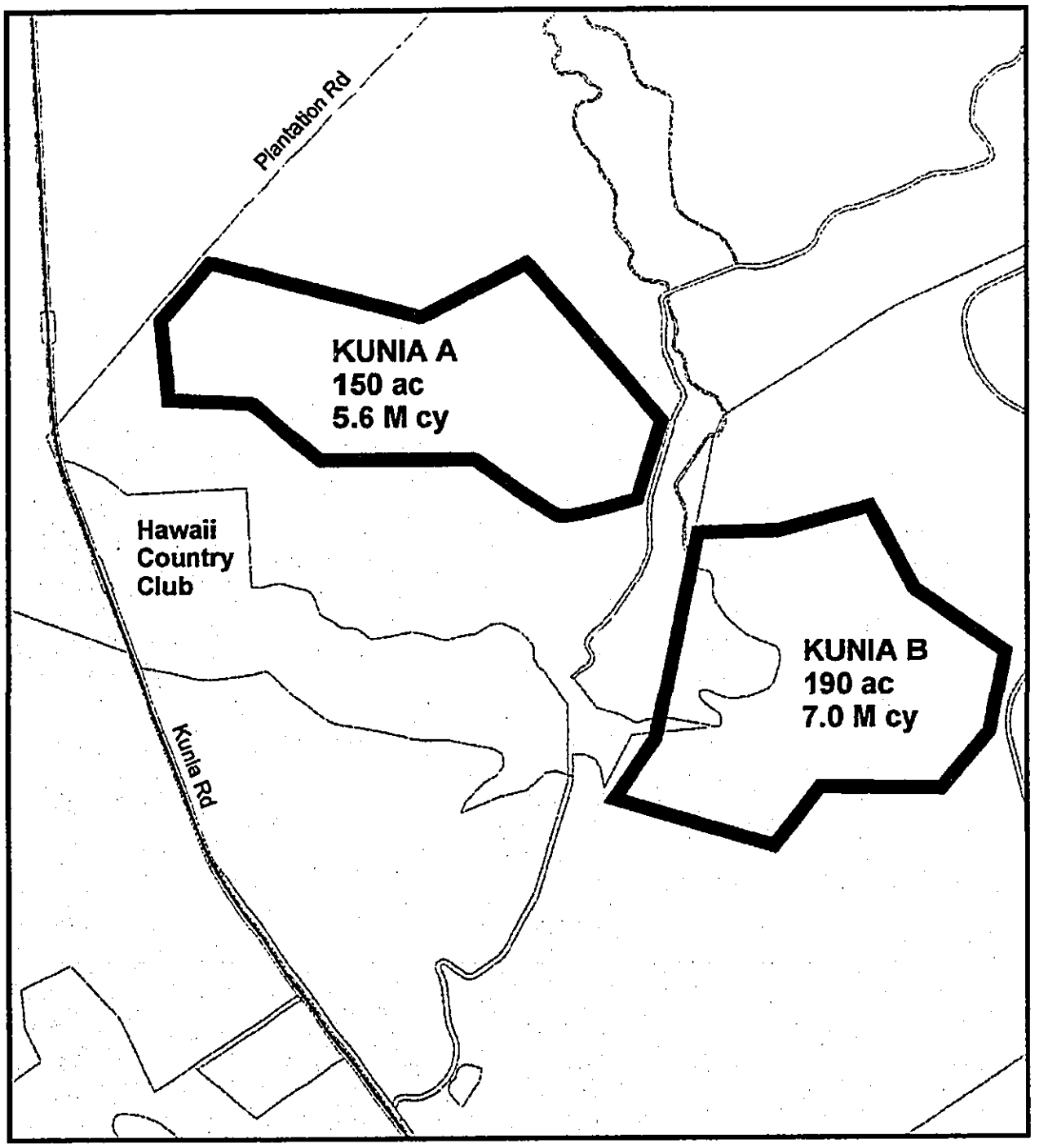
* Source: C & C Honolulu, ENV 2001
IDS Maps 1998, C & C Honolulu

23. **KUNIA SITE A** - Both Kunia Sites A and Site B are located in Hoaeae, north of the H-1 Freeway, and east of Kunia Road. Site A is located in Huliwai Gulch. Elevation of the site ranges from approximately 600 feet to 760 feet MSL (**Figure 4-22A**).

TMK:	9-4-4:por 4
Acreage:	±150
Ownership:	Estate of James Robinson et al
Adjoining Land Uses:	This site adjoins the Hawaii Country Club which is located to the south. East of the site is the Mililani residential development.
Cover Material:	Cover material is anticipated to be available on site
Soils Classification:	Kawaihapai clay loam, 2 to 6% slopes Wahiawa silty clay, 3 to 8% slopes Kolekole silty clay loam, 1 to 6% slopes Kunia silty clay, 3 to 8% slopes Helemano silty clay, 30 to 90% slopes
City and County of Honolulu Zoning:	Ag-1
State Land Use District:	Agricultural
Capacity:	5.6 million cubic yards
Lifespan:	±9.3 years (based on 0.6 million cubic yards per year required)



LEGEND

▬▬▬	Site Boundary
INSIDE	Underground Infiltration Control (UIC) Line
INSIDE	Groundwater Protection Zone (GPZ) Line

FIGURE 4-22A
Kunia A & B

0 500 1000 1500 2000 2500 3000 FEET

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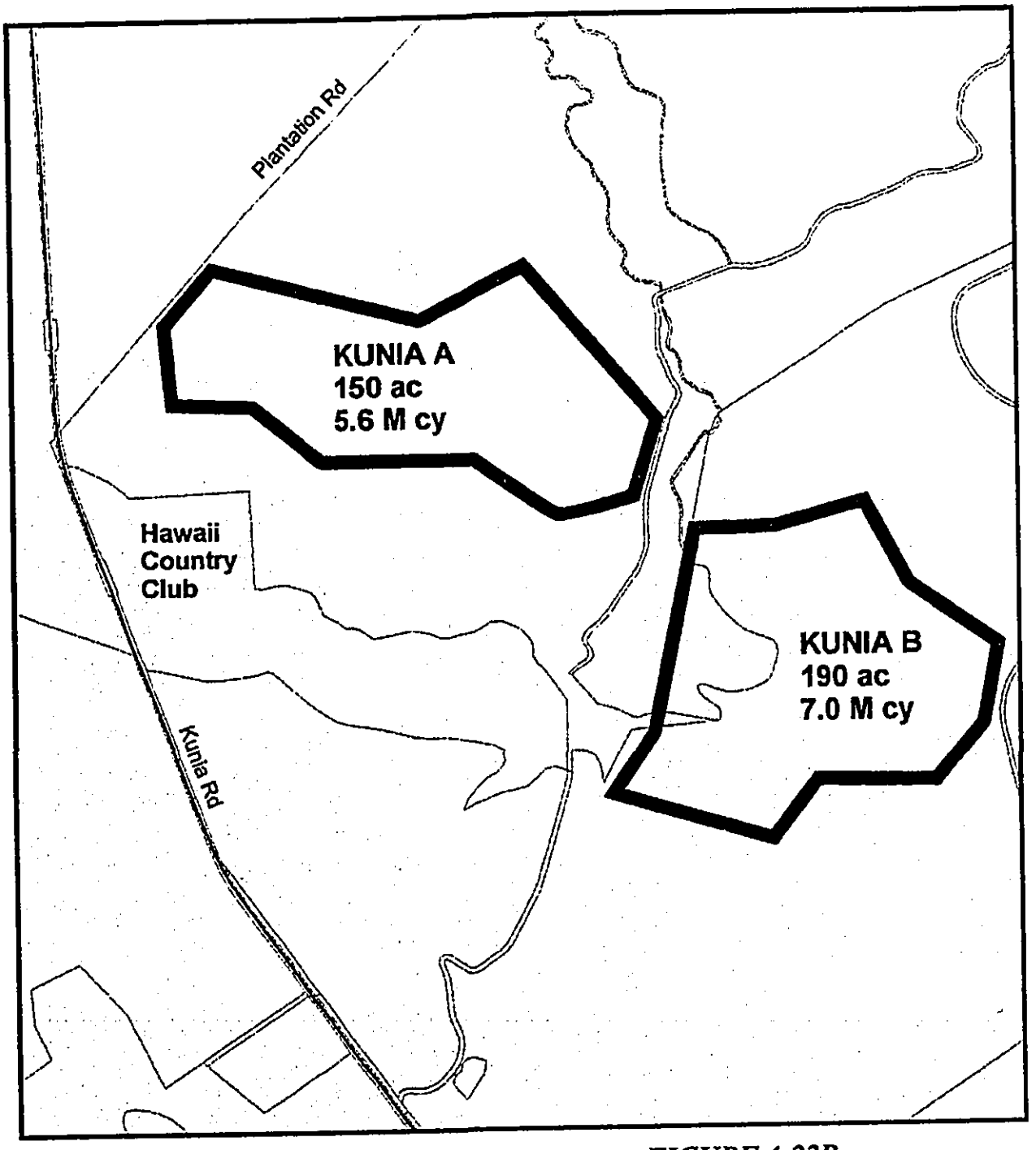
* Source: C & C Honolulu, ENV 2001
IDS Maps 1998, C & C Honolulu

24. **KUNIA SITE B** - Kunia Site B is located in Ekahanui Gulch and a portion of Poliwai Gulch, adjacent to and east of the Hawaii Country Club Golf Course. Site elevation ranges from approximately 400 feet to 560 feet MSL. **(Figure 4-22B).**

TMK:	9-4-3:por 19
Acreage:	±190
Ownership:	Estate of James Robinson
Adjoining Land Uses:	This site adjoins the Hawaii Country Club which is located to the west. East of the site is the Mililani residential development.
Cover Material:	Cover material is anticipated to be available on site
Soils Classification:	Lahaina silty clay, 7 to 15% slopes Wahiawa silty clay, 3 to 8% slopes Wahiawa silty clay, 8 to 15% slopes Kunia silty clay, 0 to 3% slopes Kunia silty clay, 3 to 8% slopes
City and County of Honolulu Zoning:	Ag-1
State Land Use District:	Agricultural
Capacity:	7 million cubic yards
Lifespan:	±11.7 years (based on 0.6 million cubic yards per year required)



LEGEND

▬▬▬	Site Boundary
INSIDE	Underground Infiltration Control (UIC) Line
INSIDE	Groundwater Protection Zone (GPZ) Line

FIGURE 4-22B
Kunia A & B

0 500 1000 1500 2000 2500 3000
FEET

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• Source: C & C Honolulu, ENV 2001
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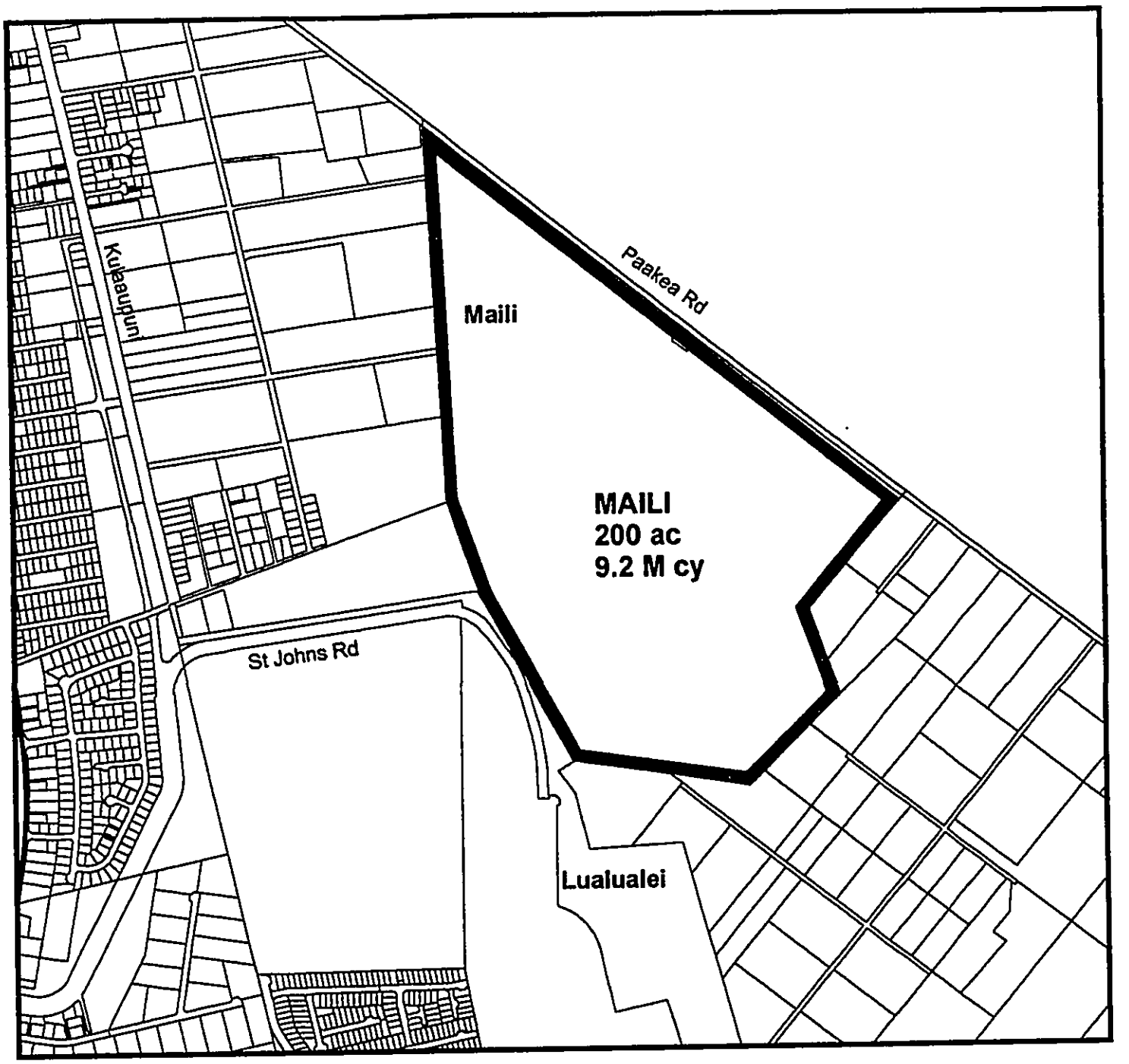
25. **MAILI** - This site is located in the Waianae District of Leeward Oahu. The site is 3,500 feet mauka of Farrington Highway, 4 miles northwest of Nanakuli and 3 miles south of Waianae. Elevation of the site averages approximately 40 feet MSL. **(Figure 4-23).**

TMK:	8-7-10:3
Acreage:	±200
Ownership:	Lone Star Hawaii
Adjoining Land Uses:	The site is currently used for limestone quarrying operations. The adjoining town of Waianae is located immediately surrounding the site.
Cover Material:	Available on site
Soils Classification:	Mamala stony silty clay loam, 0 to 12% slopes Lualualei clay, 0 to 2% slopes
City and County of Honolulu Zoning:	Ag-1
State Land Use District:	Agricultural
Capacity:	9.2 million cubic yards
Lifespan:	±15.3 years (based on 0.6 million cubic yards per year required)



LEGEND

▬▬▬	Site Boundary
OUTSIDE	Underground Infiltration Control (UIC) Line
OUTSIDE	Groundwater Protection Zone (GPZ) Line

FIGURE 4-23
Maili

0 500 1000 1500 2000 FEET

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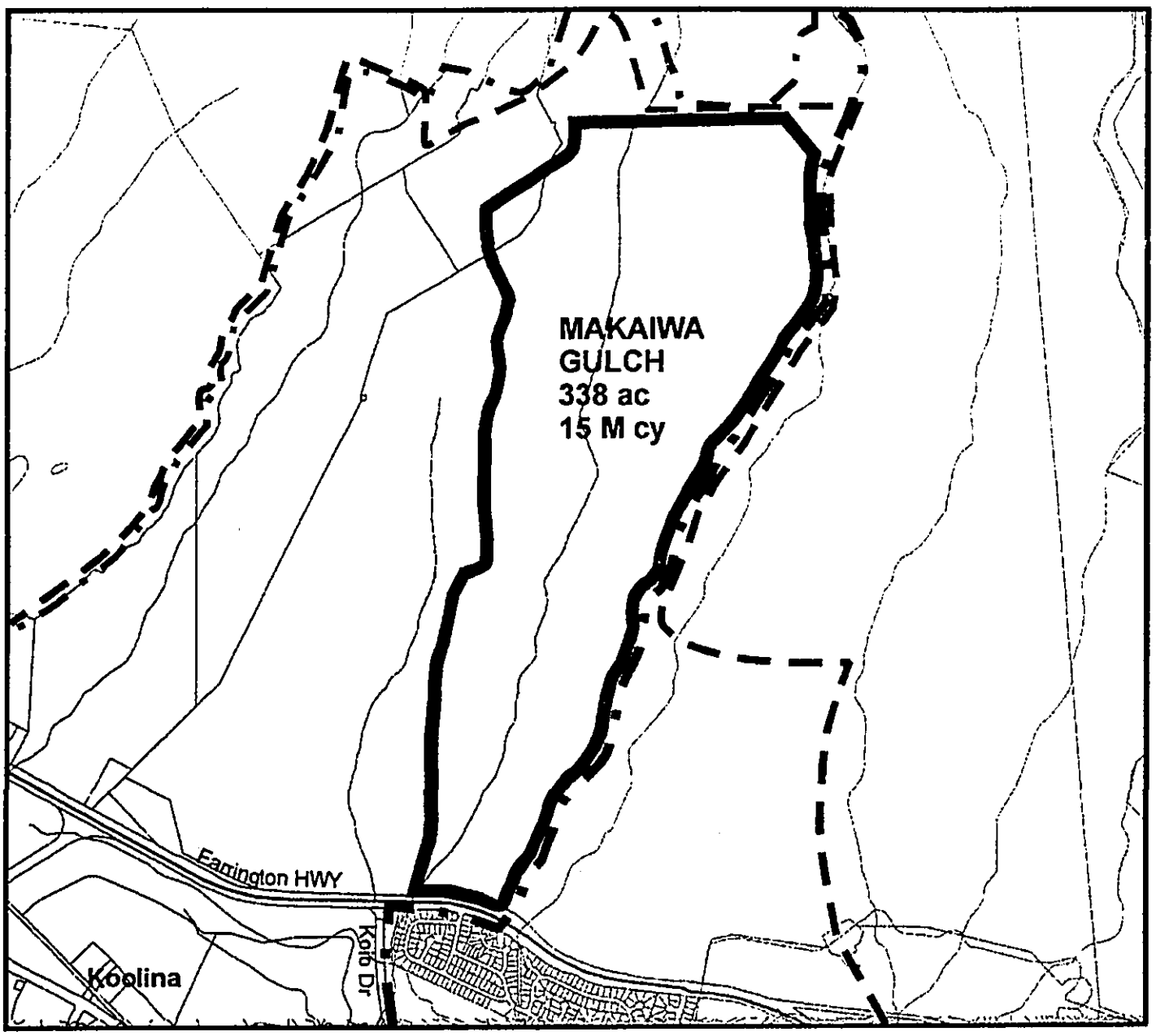
* Source: C & C Honolulu, ENV 2001
IDS Maps 1998, C & C Honolulu

26. MAKAIWA - This site is located 1.5 miles northwest of Puu Palailai, north of Farrington Highway, 1.6 miles south of Puu Manawahua, and 1.3 miles east of Kahe Point. Elevation ranges from approximately 120 feet to +600 feet MSL (**Figure 4-24**).

TMK:	9-2-3
Acreage:	±338 (±254 usable)
Ownership:	Estate of James Campbell
Adjoining Land Uses:	The Honokai Hale residential subdivision is located immediately across Farrington Highway, southwest of the site. Waimanalo Gulch Sanitary Landfill is located north and to the west of the site.
Cover Material:	Available on site
Soils Classification:	Stony steep land Mahana Badland Complex Lualualei extremely stony clay, 3 to 35% slopes Helemano silty clay, 30 to 90% slopes
City and County of Honolulu Zoning:	Ag-2
State Land Use District:	Agricultural
Capacity:	15 million cubic yards
Lifespan:	±25 years (based on 0.6 million cubic yards per year required)



LEGEND

Site Boundary

Underground Infiltration Control (UIC) Line

Groundwater Protection Zone (GPZ) Line

FIGURE 4-24
Makaiwa Gulch

0 500 1000 1500 2000 2500 3000 FEET

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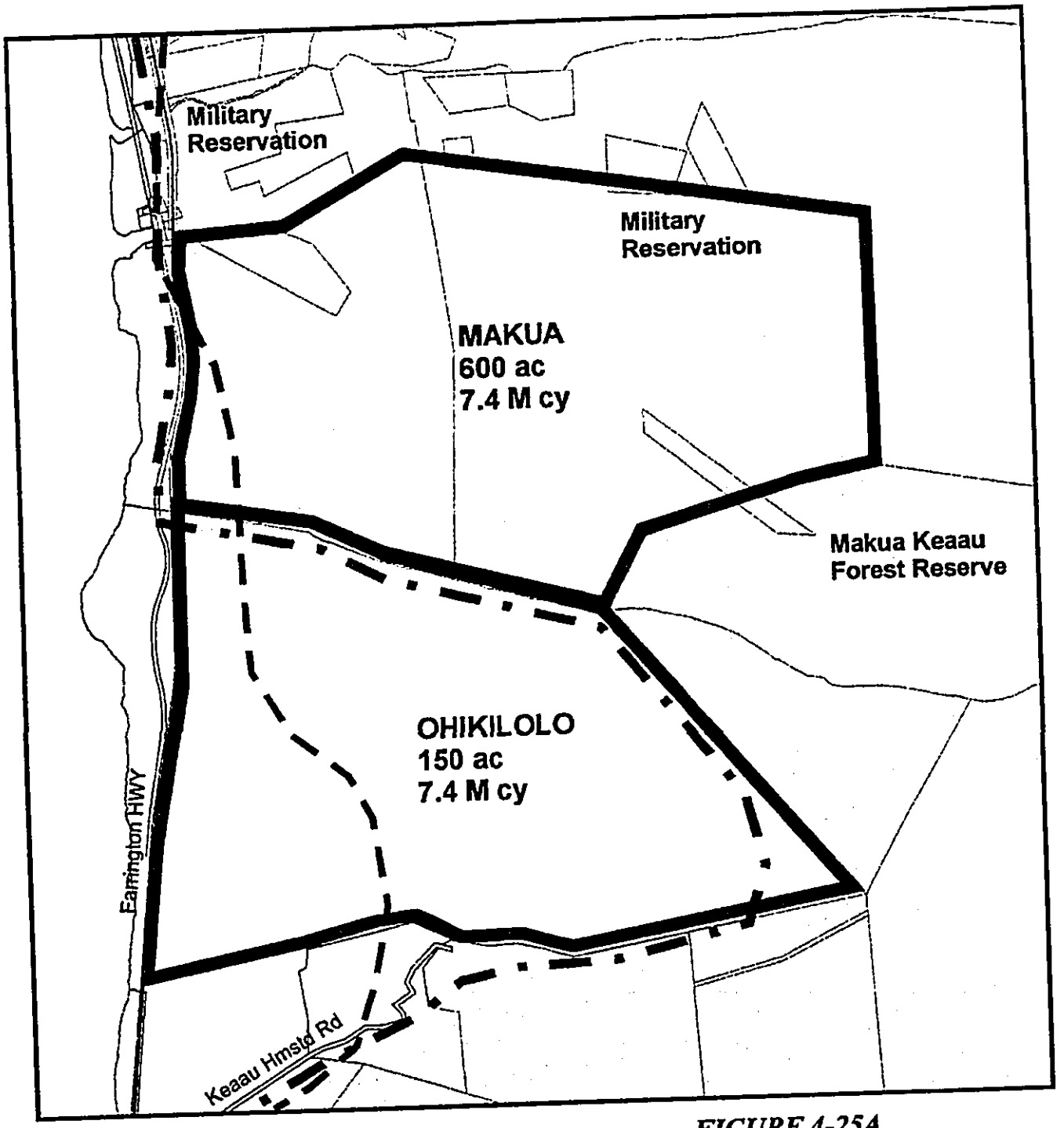
* Source: C & C Honolulu, ENV 2001
IDS Maps 1998, C & C Honolulu

27. **MAKUA** - This site is located in Makua Valley, 5 miles southeast of Kaena Point, 4 miles north of Makaha Valley on the northwestern coast of Leeward Oahu. Elevation ranges from approximately 50 feet to +400 feet MSL. **(Figure 4-25A).**

TMK:	8-1-1 and 8-2-1
Acreage:	±600
Ownership:	Federal Government (U.S. Military Reservation). Use of the site for military purposes would increase difficulty of site acquisition.
Adjoining Land Uses:	Farrington Highway is west of the site with coastal waters of the Pacific Ocean beyond. Further north is the Kaena Point State Park.
Cover Material:	Available on site
Soils Classification:	Stony land Lualualei extremely stony clay, 3 to 35% slopes Rock outcrop Pulehu very stony clay loam, 0 to 12% slopes
City and County of Honolulu Zoning:	P-1
State Land Use District:	Conservation
Capacity:	7.4 million cubic yards
Lifespan:	±12.3 years (based on 0.6 million cubic yards per year required)



LEGEND

- Site Boundary
- Underground Infiltration Control (UIC) Line
- Groundwater Protection Zone (GPZ) Line

FIGURE 4-25A
Makua & Ohikilolo

0 500 1000 1500 2000 2500 3000 FEET

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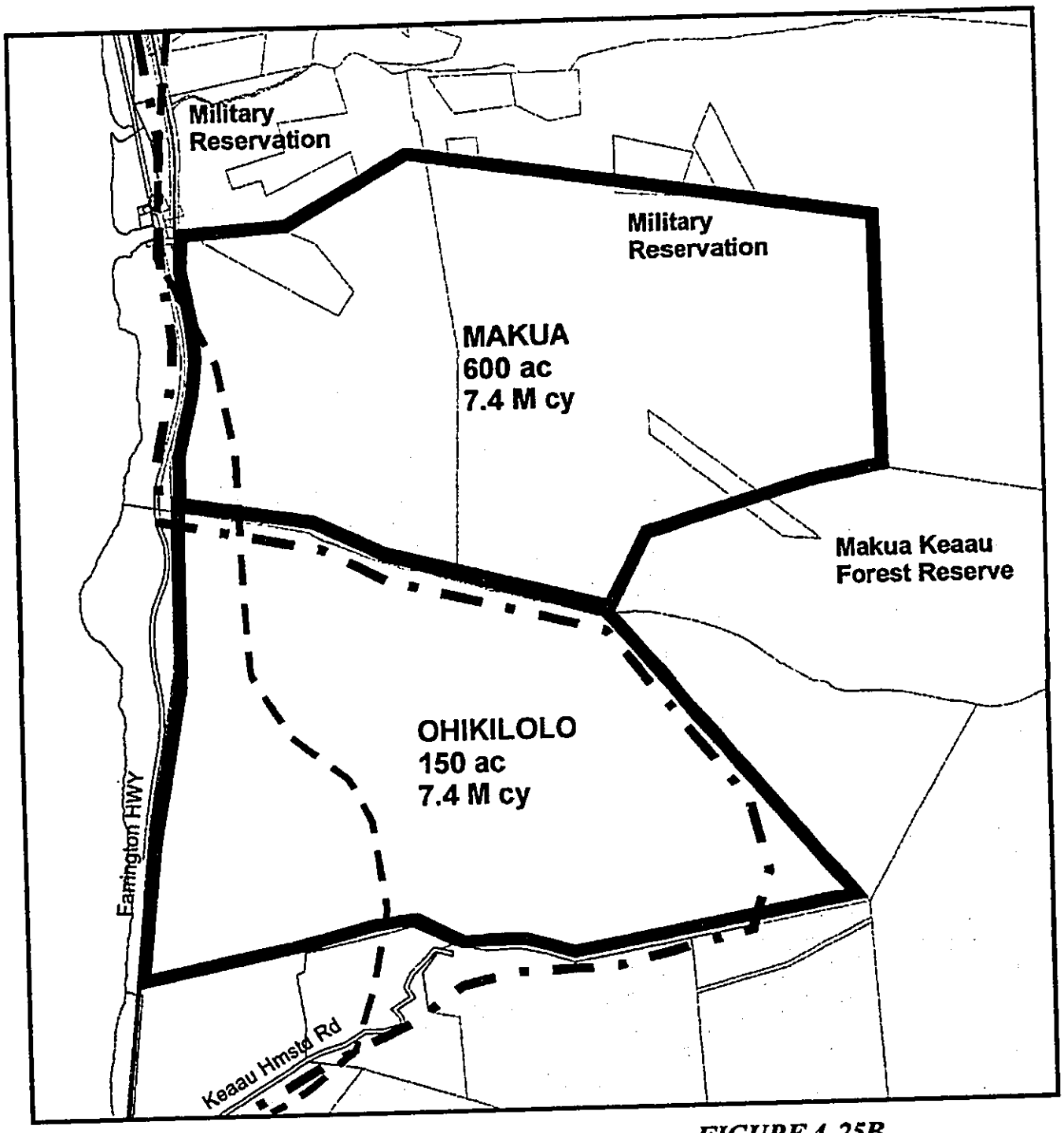
* Source: C & C Honolulu, ENV 2001
IDS Maps 1998, C & C Honolulu

28. **OHIKILOLO** - This site is located adjacent and south of the Makua Landfill Site. It is located in Ohikilolo in the north portion of Keaau Valley, 3 miles north of Makaha Valley, and 1 mile south of Makua Valley in Leeward Oahu **(Figure 4-25)**.

TMK:	8-3-1:13
Acreage:	±706
Ownership:	Alpha Kai Corporation et al
Adjoining Land Uses:	The site is immediately south of the Makua Landfill Site alternative.
Cover Material:	Some available on site, but imported cover material is necessary
Soils Classification:	Lolekaa silty clay, 15 to 25% slopes Lualualei clay, 0 to 2% slopes Lualualei stony clay, 2 to 6% slopes Lualualei extremely stony clay, 3 to 35% slopes Pulehu clay loam, 0 to 3% slopes Pulehu very stony clay loam, 0 to 12% slopes Rock land Rock outcrop Stony land Stony steep land
City and County of Honolulu Zoning:	Ag-2 and P-1
State Land Use District:	Agricultural and Conservation
Capacity:	15.6 million cubic yards
Lifespan:	±26 years (based on 0.6 million cubic yards per year required)



LEGEND

Site Boundary

Underground Infiltration Control (UIC) Line

Groundwater Protection Zone (GPZ) Line

FIGURE 4-25B
Makua & Ohikilolo

0 500 1000 1500 2000 2500 3000
FEET

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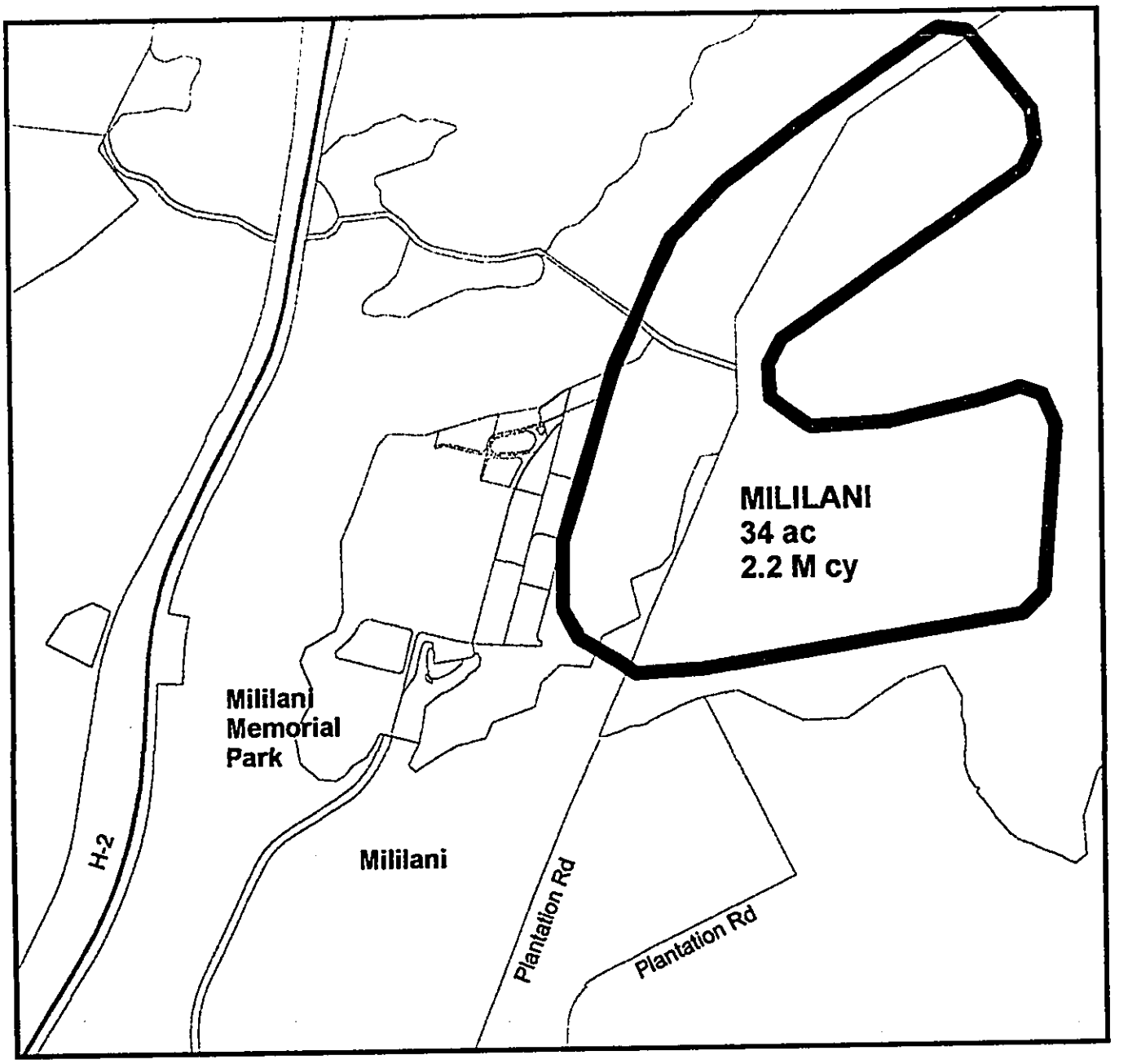
* Source: C & C Honolulu, ENV 2001
IDS Maps 1998, C & C Honolulu

29. **MILILANI** - This site is comprised of one of the major gullies connected to Panakauahi Gulch, adjacent to the Mililani Memorial Park. The site is roughly adjacent and east of the H-1 Freeway. Elevation ranges from approximately 560 feet to +600 feet MSL. **(Figure 4-26).**

TMK:	9-5
Acreage:	±34
Ownership:	Castle and Cooke, Inc., and the Estate of Bernice P. Bishop
Adjoining Land Uses:	
	Mililani Town lies west of the site and Gentry Waipio lies further south and to the west of the site.
Cover Material:	Available on site
Soils Classification:	Manana silty clay, 12 to 25% slopes, eroded Wahiawa silty clay, 0 to 3% slopes Wahiawa silty clay, 3 to 8% slopes Manana silty clay, 3 to 8% slopes Manana silty clay loam, 2 to 6% slopes
City and County of Honolulu Zoning:	P-2
State Land Use District:	Agricultural
Capacity:	2.2 million cubic yards
Lifespan:	±3.7 years (based on 0.6 million cubic yards per year required)



LEGEND

▬▬▬	Site Boundary
INSIDE	Underground Infiltration Control (UIC) Line
INSIDE	Groundwater Protection Zone (GPZ) Line

FIGURE 4-26
Mililani

0 500 1000 1500 2000 FEET

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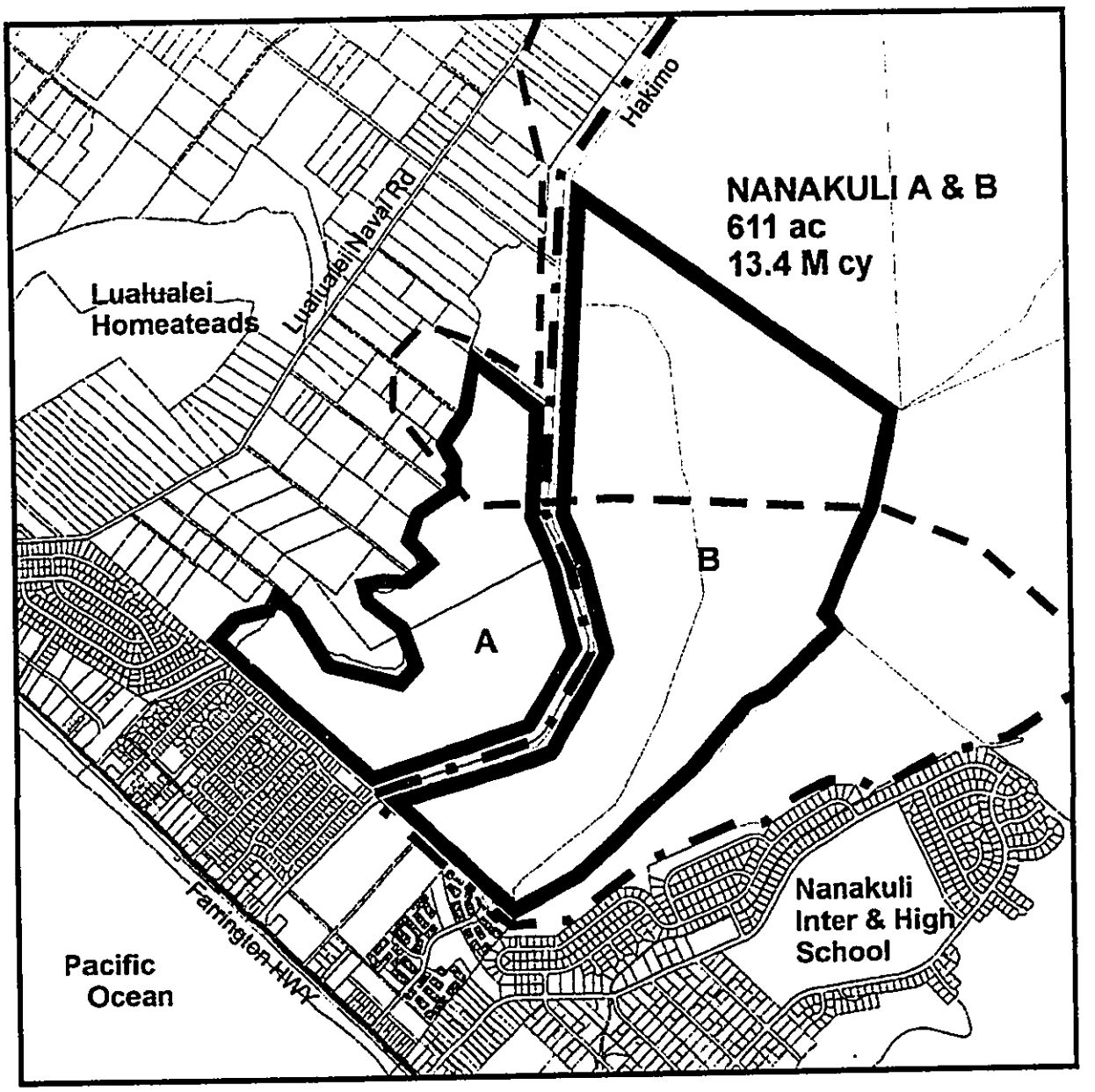
IDS Maps 1998, C & C Honolulu

30. **NANAKULI** - This site is located 2,000 feet mauka of Farrington Highway and Nanaikapono Beach Park, 4,000 feet west of Puu Helakala, and 4,000 feet east, southeast of Puu O Hulu Uka. Elevation ranges from approximately 40 feet to +300 feet MSL. **(Figure 4-27)**.

TMK:	8-7-9:1 & 3 and 8-7-21:26
Acreage:	±611 (±288 usable)
Ownership:	PVT Holdings, Inc., and PVT Land Company Ltd.
Adjoining Land Uses:	Commercial uses within Nanakuli town are located immediately west and south of the site. Agricultural lots are located immediately tot he northwest. South and west of the site are residences and the Nanakuli Intermediate and High School.
Cover Material:	Cover material is anticipated to be available on site
Soils Classification:	Lualualei clay, 2 to 6% slopes Lualualei extremely stony clay, 3 to 35% slopes Mamala stony silty clay loam, 0 to 12% slopes Pulehu very stony clay loam, 0 to 12% slopes Rock land
City and County of Honolulu Zoning:	P-1, Ag-2
State Land Use District:	Urban, Agricultural, and Conservation
Capacity:	13.4 million cubic yards
Lifespan:	±22.3 years (based on 0.6 million cubic yards per year required)



LEGEND

- Site Boundary
- Underground Infiltration Control (UIC) Line
- Groundwater Protection Zone (GPZ) Line

FIGURE 4-27
Nanakuli A & B

0 500 1000 1500 2000 2500 3000 FEET

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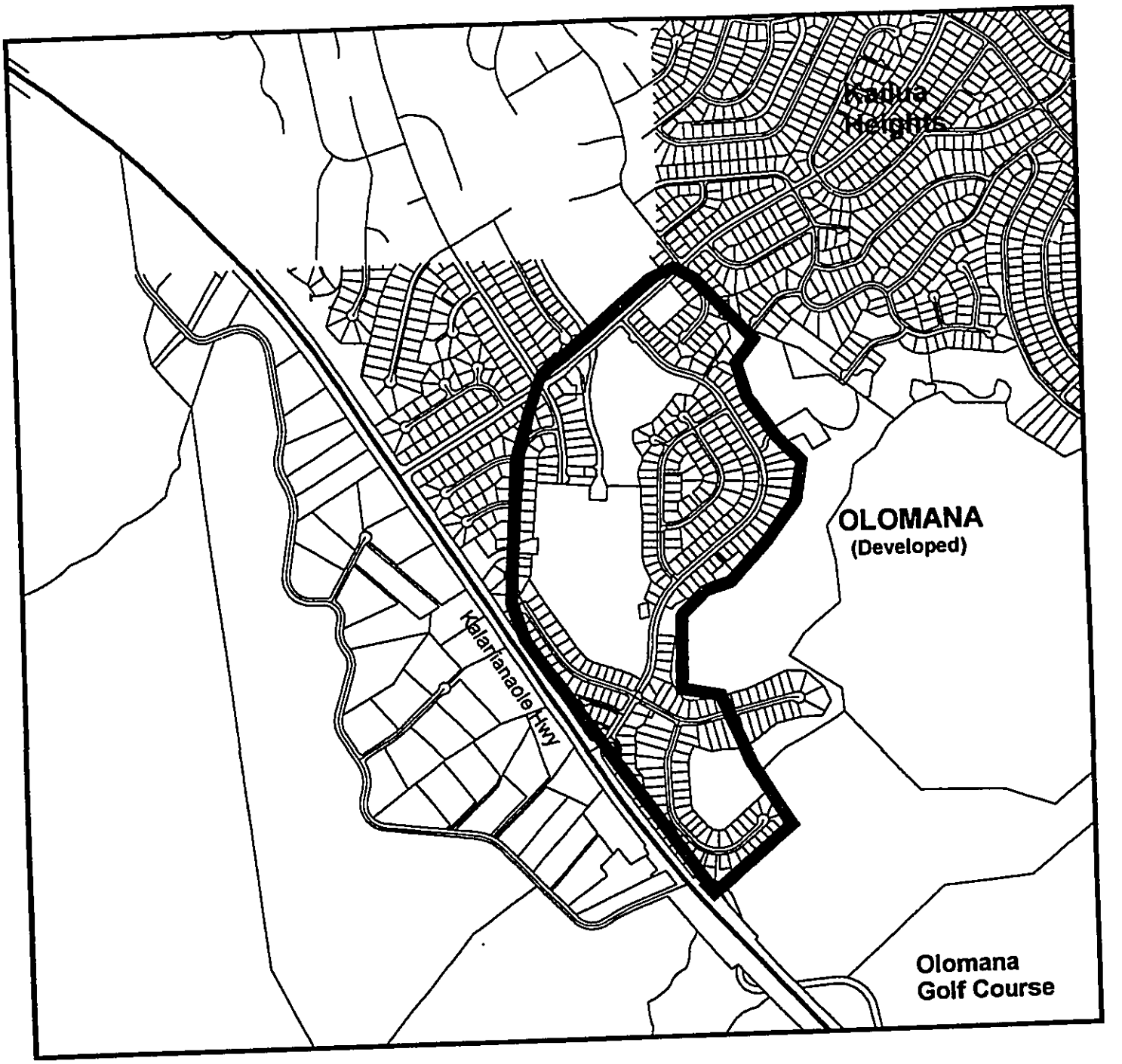
• Source: C & C Honolulu, ENV 2001
IDS Maps 1998, C & C Honolulu

31. **OLOMANA** - No longer viable for development. The identification of this site is provided in **Figure 4-28.**



LEGEND

▬▬▬	Site Boundary
OUTSIDE	Underground Infiltration Control (UIC) Line
OUTSIDE	Groundwater Protection Zone (GPZ) Line

NOTE: TMK Parcel Information for upper quadrant unavailable on IDS Map.

FIGURE 4-28
Olomana

0 500 1000 1500 2000 FEET

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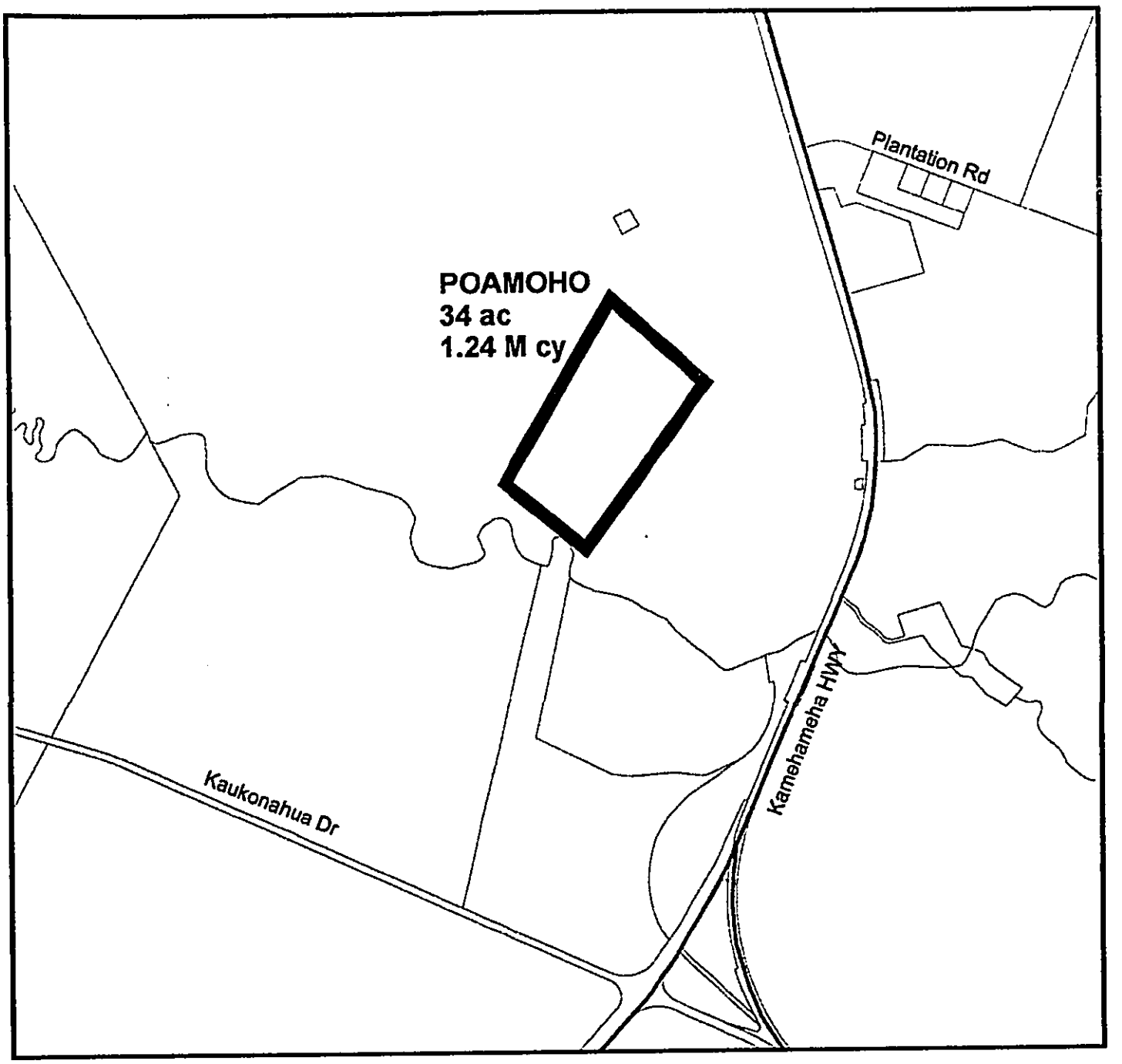
32. **POAMOHO** - This site is located adjacent to agricultural fields and is approximately 2.6 miles north of the town of Wahiawa. Kamehameha Highway is located to the east of the site. Elevation of the site ranges from approximately 840 feet to 920 feet MSL. **(Figure 4-29).**

TMK:	4-2
Acreage:	±5
Ownership:	To be determined based on site boundary
Adjoining Land Uses:	The site is primarily in open space agricultural uses. Poamoho Camp is located approximately 0.25 miles to the south and the town of Whitmore Village is located southeast approximately 0.5 miles away.
Cover Material:	Cover material is anticipated to be available on site
Soils Classification:	Wahiawa silty clay, 3 to 8% slopes Wahiawa silty clay, 8 to 15% slopes Helemano silty clay, 30 to 90% slopes
City and County of Honolulu Zoning:	Ag-1
State Land Use District:	Agricultural
Capacity:	0.7 million cubic yards
Lifespan:	±1.2 years (based on 0.6 million cubic yards per year required)



LEGEND

▬▬▬	Site Boundary
INSIDE	Underground Infiltration Control (UIC) Line
INSIDE	Groundwater Protection Zone (GPZ) Line

FIGURE 4-29
Poamoho

0 500 1000 1500 2000 FEET

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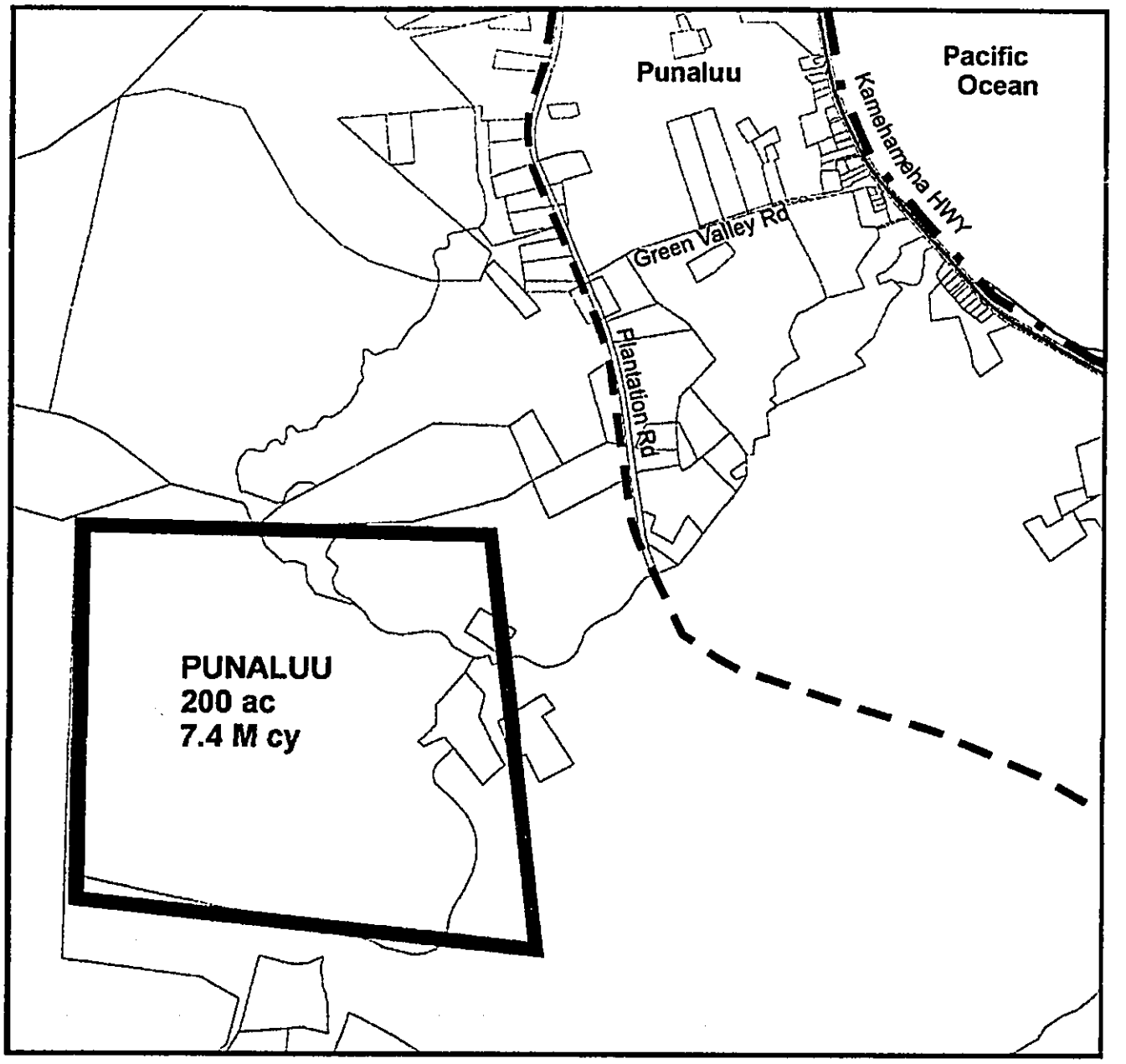
* Source: C & C Honolulu, ENV 2001
IDS Maps 1998, C & C Honolulu

33. **PUNALUU** - This site is located in Windward Oahu, in Punaluu. The is site is surrounded by agricultural land uses with Kamehameha Highway located east, northeast of the site. Elevation ranges from approximately 40 feet to +300 feet MSL. (**Figure 4-30**).

TMK:	5-3
Acreage:	±200
Ownership:	To be determined based on site boundary
Adjoining Land Uses:	Adjoining land uses include agriculture and open space. Punaluu Beach Park and the Pacific Ocean is located east, northeast of the site. Along Kamehameha Highway are single family residences and farm lots.
Cover Material:	Cover material is anticipated to be available on site
Soils Classification:	Lolekaa silty clay, 8 to 15% slopes Lolekaa silty clay, 25 to 40% slopes Lolekaa silty clay, 40 to 70% slopes Waikane silty clay, 40 to 70% slopes, eroded Hanalei silty clay, 2 to 6% slopes Waialua stony silty clay, 3 to 8 percent slopes
City and County of Honolulu Zoning:	Ag-2
State Land Use District:	Agricultural
Capacity:	7.4 million cubic yards
Lifespan:	±12.3 years (based on 0.6 million cubic yards per year required)



LEGEND

- Site Boundary
- Underground Infiltration Control (UIC) Line
- Groundwater Protection Zone (GPZ) Line

FIGURE 4-30
Punaluu

0 500 1000 1500 2000 FEET

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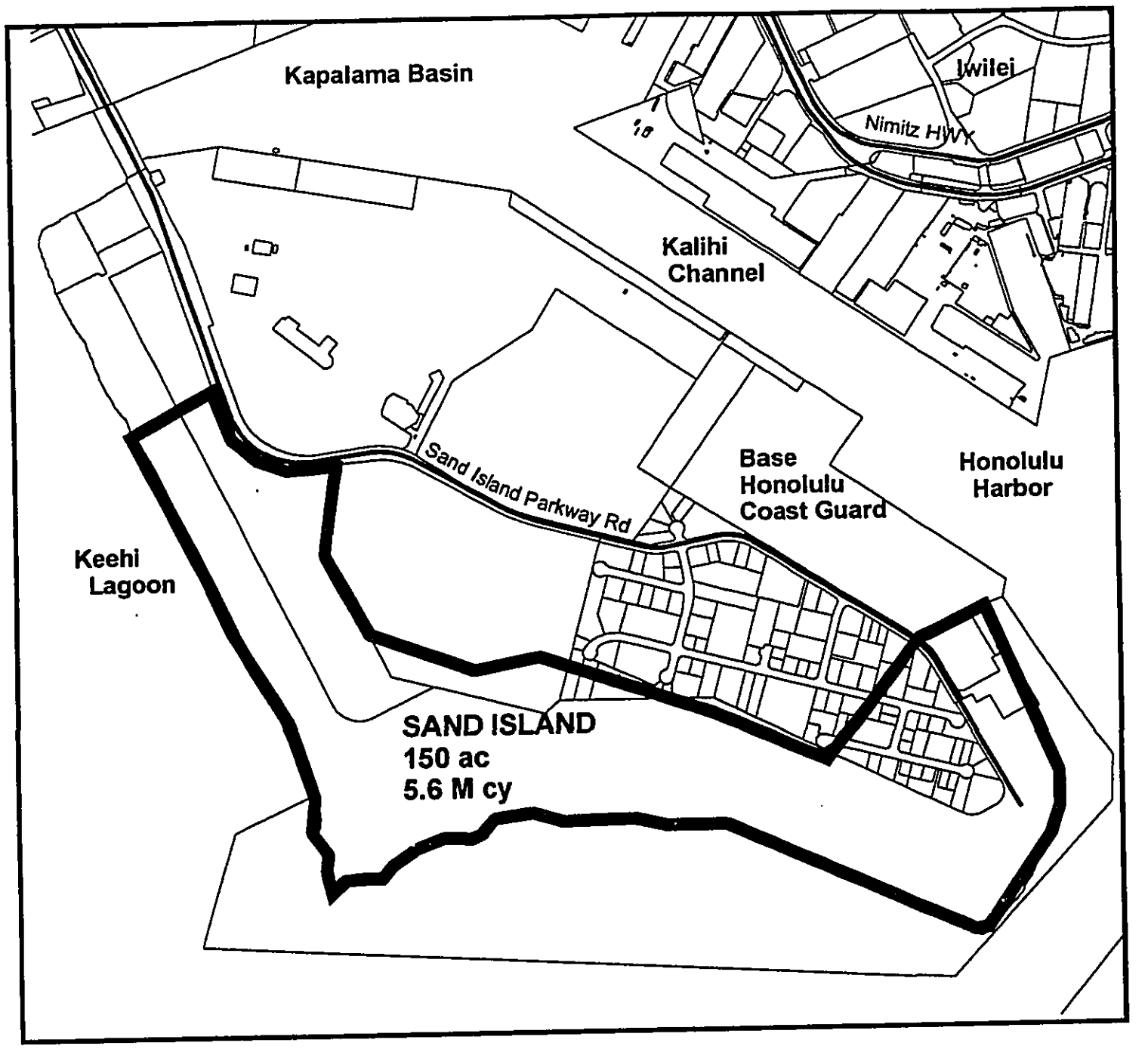
IDS Maps 1998, C & C Honolulu

34. **SAND ISLAND** - This site is located at Sand Island State Park on the south and east sides of Sand Island in Honolulu Harbor across the downtown commercial and Iwilei Industrial areas on the south Leeward Coast of Oahu. Elevation of the site averages approximately 40 feet MSL. **(Figure 4-31).**

TMK:	1-5-41:por 6
Acreage:	±150
Ownership:	State of Hawaii
Adjoining Land Uses:	Existing site is a State Park. Surrounding land uses include commercial and industrial activities. The Sand Island Wastewater Treatment Plant is located in the approximate center of Sand Island.
Cover Material:	Must be imported
Soils Classification:	Fill land
City and County of Honolulu Zoning:	P-2
State Land Use District:	Urban
Capacity:	5.6 million cubic yards
Lifespan:	±9.3 years (based on 0.6 million cubic yards per year required)



LEGEND

▬▬▬	Site Boundary
OUTSIDE	Underground Infiltration Control (UIC) Line
OUTSIDE	Groundwater Protection Zone (GPZ) Line

FIGURE 4-31
Sand Island

0 500 1000 1500 2000 FEET

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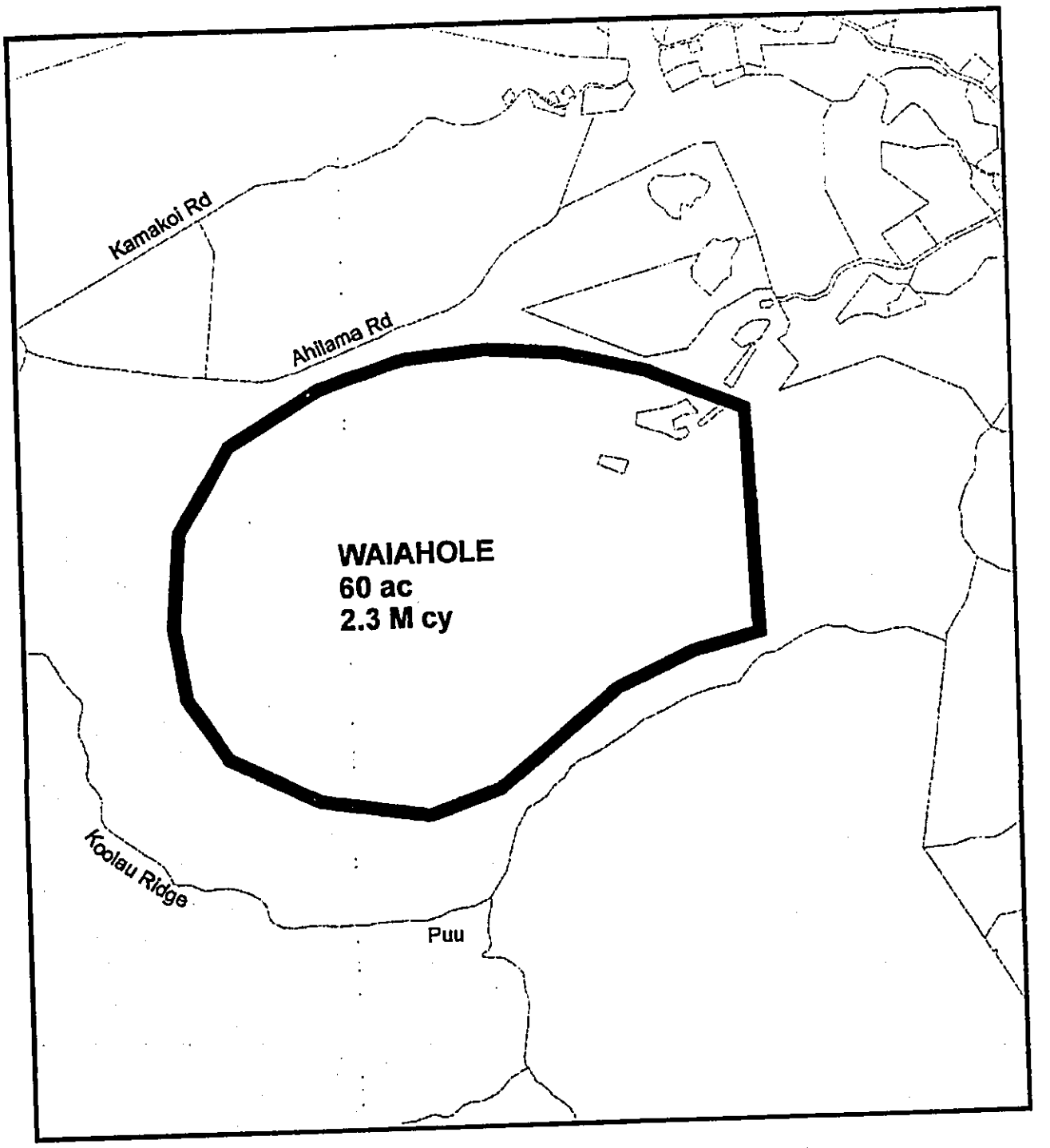
35. **WAIAHOLE** - This site is located in Windward Oahu in Waihole. The site is surrounded by open space and agricultural land uses. Kamehameha Highway is located east of the site. Elevation ranges from approximately 160 feet to +400 feet MSL. **(Figure 4-32).**

TMK:	4-8
Acreage:	±60
Ownership:	To be determined based on site boundary
Adjoining Land Uses:	Adjoining land uses include agriculture and open space. Waihole Elementary and Intermediate School is located east of the site with the Waihole Beach Park and Pacific Ocean located further east. Along Kamehameha Highway are single family residences and farm lots.
Cover Material:	Cover material is anticipated to be available on site.
Soils Classification:	Waikane silty clay, 25 to 40% slopes Hanalei silty clay, 0 to 2% slopes
City and County of Honolulu Zoning:	P-1 and Ag-2
State Land Use District:	Conservation and Agricultural
Capacity:	2.3 million cubic yards
Lifespan:	±3.8 years (based on 0.6 million cubic yards per year required)



LEGEND

▬▬▬	Site Boundary
INSIDE	Underground Infiltration Control (UIC) Line
INSIDE	Groundwater Protection Zone (GPZ) Line

FIGURE 4-32
Waiahole

0 500 1000 1500 2000 2500 3000 FEET

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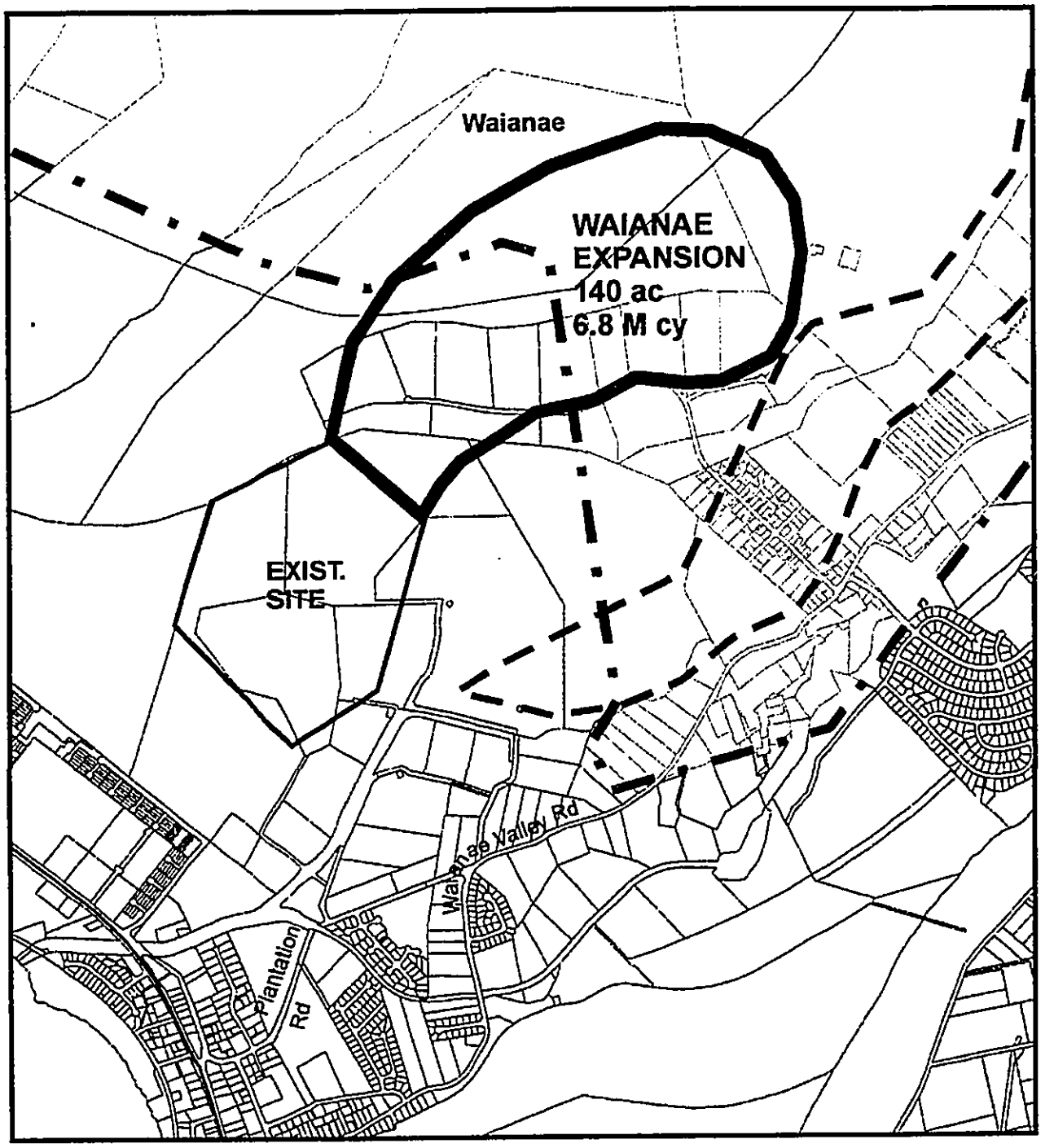
IDS Maps 1998, C & C Honolulu

36. **WAIANAE EXPANSION** - This site is located adjacent to the old Waianae Landfill, approximately 0.9 miles mauka of Farrington Highway. Elevation of the expansion site ranges from approximately 40 feet to +800 feet MSL. **(Figure 4-33).**

TMK:	8-50-3:1, 29 - 32 8-5-6:10
Acreage:	±140 (±130 usable)
Ownership:	City and County of Honolulu, Herbert K. Horita Investment Inc., and World Union Industrial Corp.
Adjoining Land Uses:	The land is surrounded by agricultural lots, some of which remain in open space and uncultivated. Southwest of the site is the Waianae Intermediate School and Farrington Highway which adjoins the school. Coastal waters of the Pacific Ocean are located further southwest, across Farrington Highway at the Waianae Regional Park..
Cover Material:	Some cover available on site. Additional cover material must be imported.
Soils Classification:	Stony Lualualei Clay, 3 to 35% slopes Rock land
City and County of Honolulu Zoning:	Ag-2
State Land Use District:	Agricultural and Conservation
Capacity:	6.8 million cubic yards
Lifespan:	±22.3 years (based on 0.6 million cubic yards per year required)



LEGEND

- Site Boundary
- Underground Infiltration Control (UIC) Line
- Groundwater Protection Zone (GPZ) Line

FIGURE 4-33
WaianaeExpansion

0 500 1000 1500 2000 2500 3000 FEET

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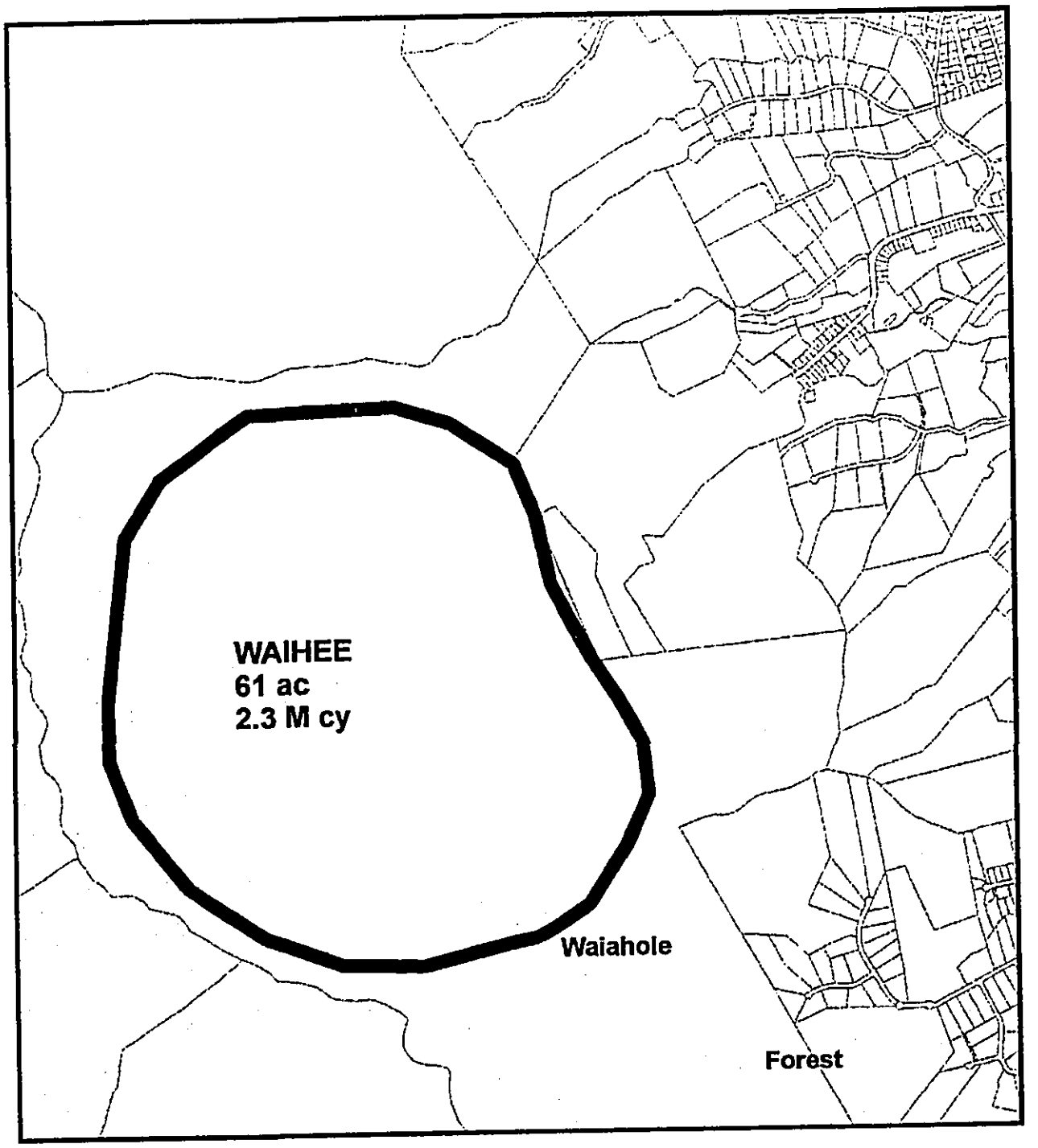
* Source: C & C Honolulu, ENV 2001
IDS Maps 1998, C & C Honolulu

37. **WAIHEE** - This site is located roughly between the Kahaluu and Waihole landfill sites in Windward Oahu. The site is located mauka of Kamehameha Highway and above the town of Kahaluu. Elevation of the site ranges from approximately +200 feet to +700 feet MSL. **(Figure 4-34).**

TMK:	4-7
Acreage:	±61
Ownership:	To be determined based on site boundary
Adjoining Land Uses:	Adjoining the site to the east is the Waihee Valley Nature Park located Mauka of Kamehameha Highway. Further Makai of the park, are residences and large lot agricultural parcels. Above the landfill site is the Waihole Forest Reserve boundary.
Cover Material:	Cover material is anticipated to be available on site.
Soils Classification:	Waikane silty clay, 40 to 70% slopes Rock outcrop
City and County of Honolulu Zoning:	P-1
State Land Use District:	Conservation
Capacity:	2.3 million cubic yards
Lifespan:	±3.8 years (based on 0.6 million cubic yards per year required)



LEGEND

- Site Boundary
- Underground Infiltration Control (UIC) Line
- Groundwater Protection Zone (GPZ) Line

FIGURE 4-34
Waihee

0 500 1000 1500 2000 2500 3000 FEET

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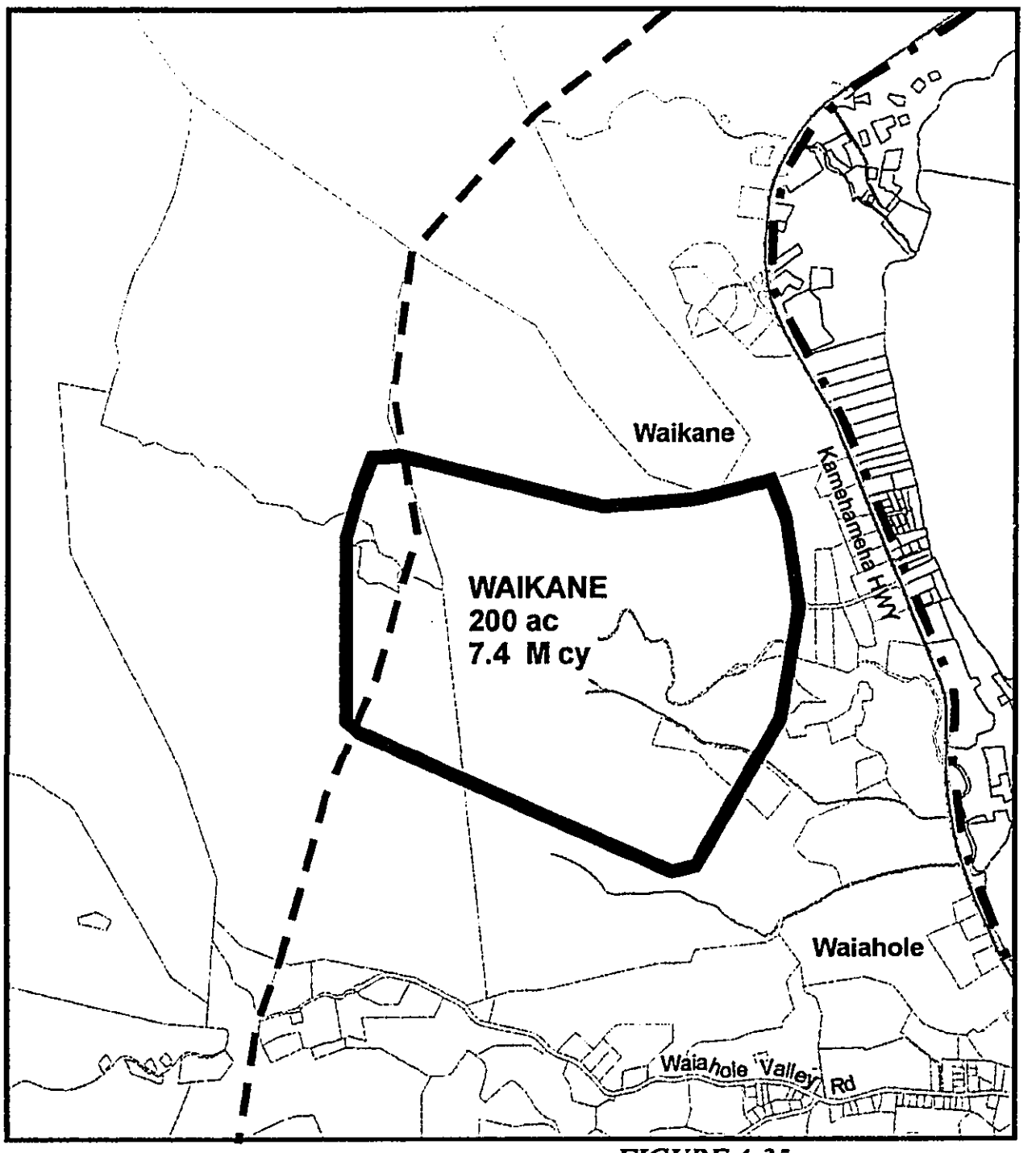
* Source: C & C Honolulu, ENV 2001
IDS Maps 1998, C & C Honolulu

38. **WAIKANE** - This site is located in Windward Oahu and is roughly between the Kaaawa and Waihole alternative landfill sites. The site is located Mauka of Kamehameha Highway and situated in the Waikane district of Oahu. Elevation ranges from approximately 120 feet to +800 feet MSL. **(Figure 4-35).**

TMK:	4-8
Acreage:	±200
Ownership:	To be determined based on site boundary
Adjoining Land Uses:	
	Adjoining the site to the east is Kamehameha Highway and Kaneohe Bay. Kualoa Regional Park and Molii Pond is located north, northwest of the site. Residences and agricultural parcels adjoin Kamehameha Highway.
Cover Material:	
	Cover material is anticipated to be available on site.
Soils Classification:	Waikane silty clay, 40 to 70% slopes Waikane silty clay, 40 to 70% slopes, eroded Lolekaa silty clay, 40 to 70% slopes
City and County of Honolulu Zoning:	Ag-2 and P-1
State Land Use District:	Agricultural and Conservation
Capacity:	9 million cubic yards
Lifespan:	±15 years (based on 0.6 million cubic yards per year required)



LEGEND

Site Boundary

Underground Infiltration Control (UIC) Line

Groundwater Protection Zone (GPZ) Line

FIGURE 4-35
Waikane

0 500 1000 1500 2000 2500 3000 FEET

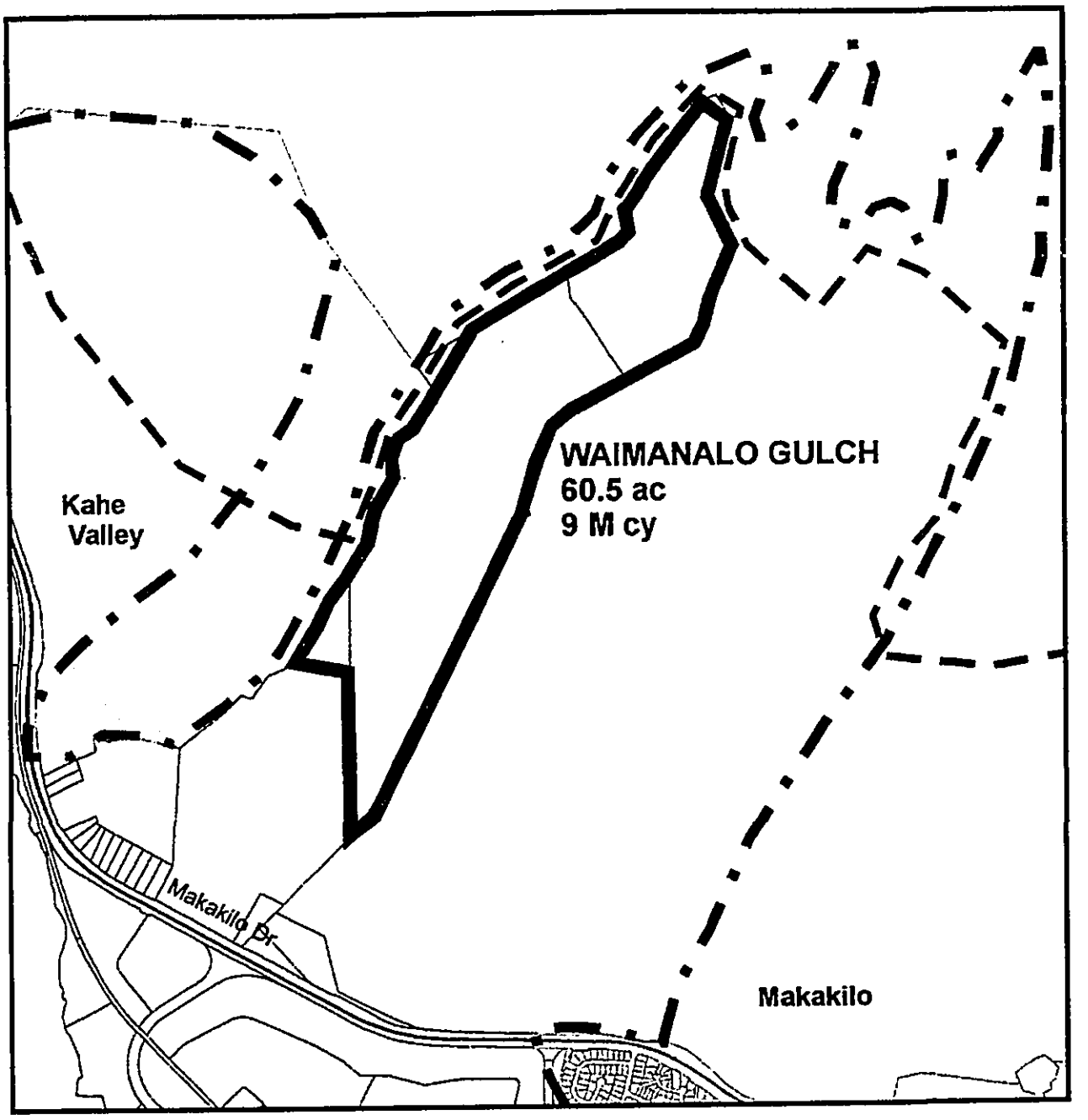
Alternatives Analysis for Disposal of Municipal Solid Waste (MSW)
Dept. Of Environmental Services (ENV) • C & C Honolulu
Waste Management of Hawaii, Inc.

R. M. TOWILL CORPORATION

* Source: C & C Honolulu, ENV 2001
IDS Maps 1998, C & C Honolulu

39. **WAIMANALO GULCH EXPANSION** - This site is within the location of the existing Waimanalo Gulch Sanitary Landfill. South of the site is the Campbell Industrial Park, Barbers Point Deep Draft Harbor, and the Ko Olina Resort which is located nearby. Southeast of the site is the Honokai Hale residential subdivision and to the east is the Makakilo residential subdivision. Immediately to the northwest is the Hawaiian Electric Power Generating Station and the Kahe Point Beach Park. Elevation of the site ranges from approximately 150 feet to +700 feet MSL. **(Figure 4-36).**

TMK:	9-2-3:72 & 73
Acreage:	±60.5
Ownership:	City and County of Honolulu
Adjoining Land Uses:	The site adjoins Farrington Highway. To the northwest is the Hawaiian Electric Kahe Power Generating Station. South of the site is Ko Olina and the Ihilani Resort. Southeast of the site is the Honokai Hale residential subdivision. Farrington Highway adjoins the landfill site.
Cover Material:	Available on site
Soils Classification:	Rock land Stony steep land
City and County of Honolulu Zoning:	Ag-2
State Land Use District:	Agricultural
Capacity:	9 million cubic yards
Lifespan:	±15 years (based on 0.6 million cubic yards per year required)



LEGEND

- Site Boundary
- Underground Infiltration Control (UIC) Line
- Groundwater Protection Zone (GPZ) Line

FIGURE 4-36
Waimanalo Gulch

0 500 1000 1500 2000 2500 3000 FEET

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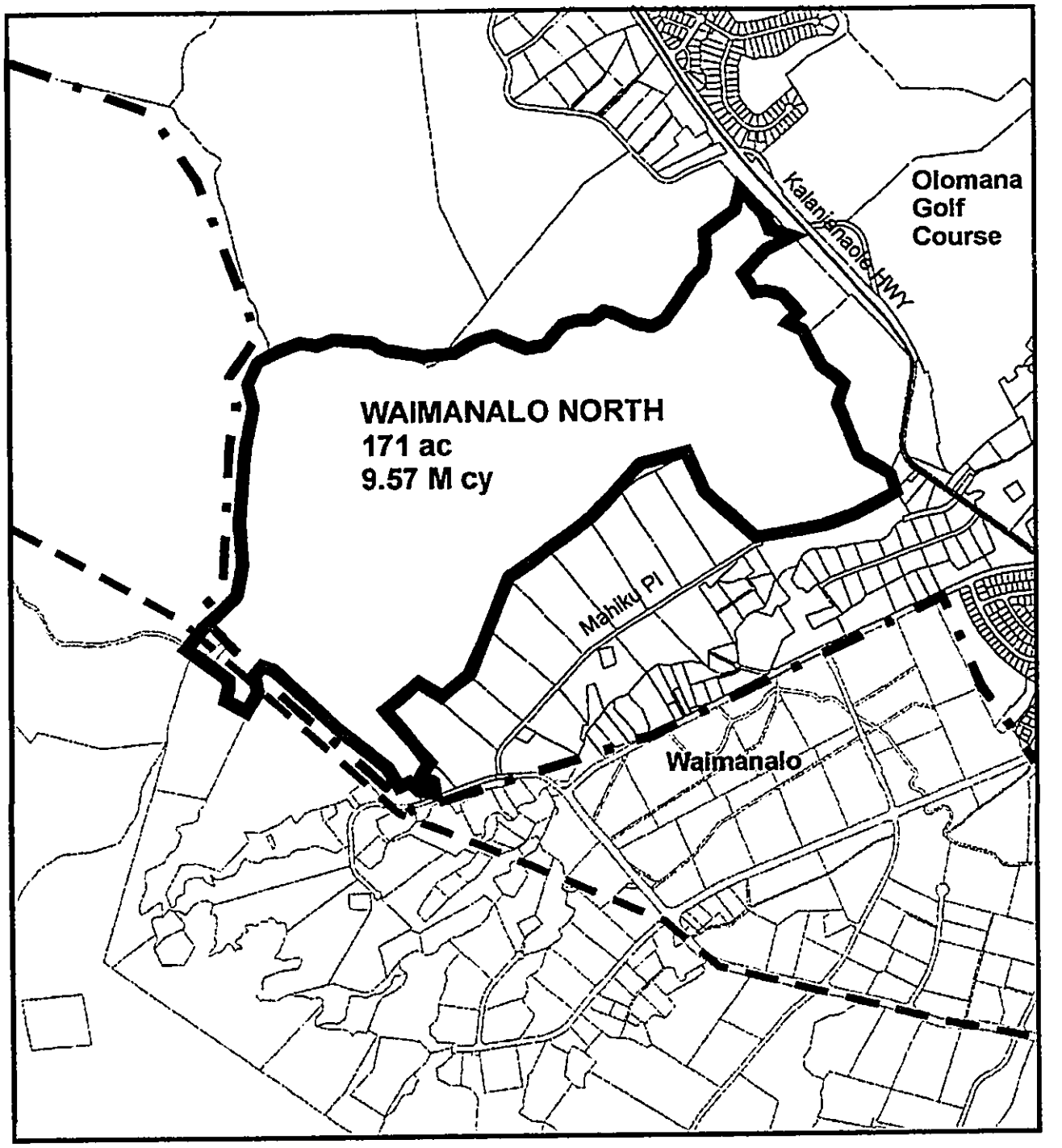
40. **WAIMANALO NORTH** - Site is located south of Kailua, west of Olomana Golf Course and Bellows Air Force Base, northwest of Waimanalo urban areas, north of Waimanalo farm lands and approximately one mile southeast of Olomana Peak. Elevation of the site ranges from approximately 160 feet to +240 feet MSL. **(Figure 4-37).**

TMK:	4-1-8:13
Acreage:	±171 (±131 usable)
Ownership:	State of Hawaii
Adjoining Land Uses:	The site is within an old quarry. The Kailua Ditch roughly adjoins the site to the west. North and east of the site is Kalanianaole Highway.
Cover Material:	Available on site
Soils Classification:	Alaeloa silty clay, 40 to 70% slopes
City and County of Honolulu Zoning:	Ag-2
State Land Use District:	Agricultural
Capacity:	9.57 million cubic yards
Lifespan:	±16 years (based on 0.6 million cubic yards per year required)



LEGEND

Site Boundary

Underground Infiltration Control (UIC) Line

Groundwater Protection Zone (GPZ) Line

FIGURE 4-37
Waimanalo North

0 500 1000 1500 2000 2500 3000 FEET

Alternatives Analysis for Disposal of Municipal Solid Waste (MSW)
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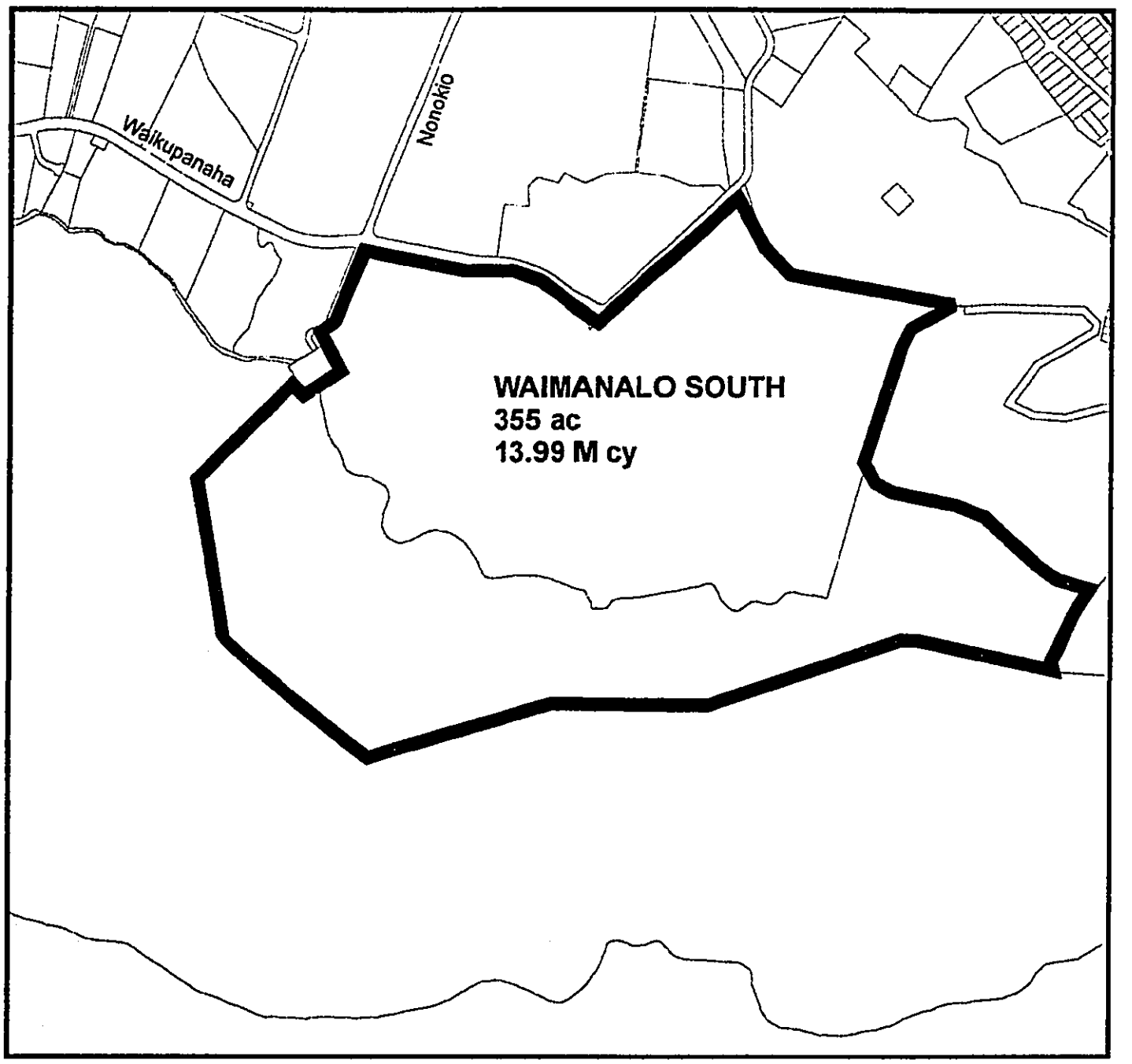
* Source: C & C Honolulu, ENV 2001
IDS Maps 1998, C & C Honolulu

41. **WAIMANALO SOUTH** - This site is located mauka and west of Waimanalo Beach Park and south of the University of Hawaii Agriculture Experiment Station. Elevation of the site ranges from approximately 320 feet to +1,000 feet MSL. **(Figure 4-38).**

TMK:	4-1
Acreage:	±355
Ownership:	State of Hawaii
Adjoining Land Uses:	Land uses surrounding the site include Waimanalo agricultural farm lots located north and to the west. Northeast of the site are urbanized lands of Waimanalo.
Cover Material:	Cover material is anticipated to be available on site
Soils Classification:	Rock outcrop Kaena very stony clay, 10 to 35% slopes Alaeloa silty clay, 40 to 70% slopes
City and County of Honolulu Zoning:	Ag-2 and P-1
State Land Use District:	Agricultural and Conservation
Capacity:	13.99 million cubic yards
Lifespan:	± 23.3 years (based on 0.6 million cubic yards per year required)



LEGEND

▬▬▬	Site Boundary
INSIDE	Underground Infiltration Control (UIC) Line
INSIDE	Groundwater Protection Zone (GPZ) Line

FIGURE 4-38
Waimanalo South

0 500 1000 1500 2000 FEET

Alternatives Analysis for Disposal of Municipal Solid Waste (MSW)
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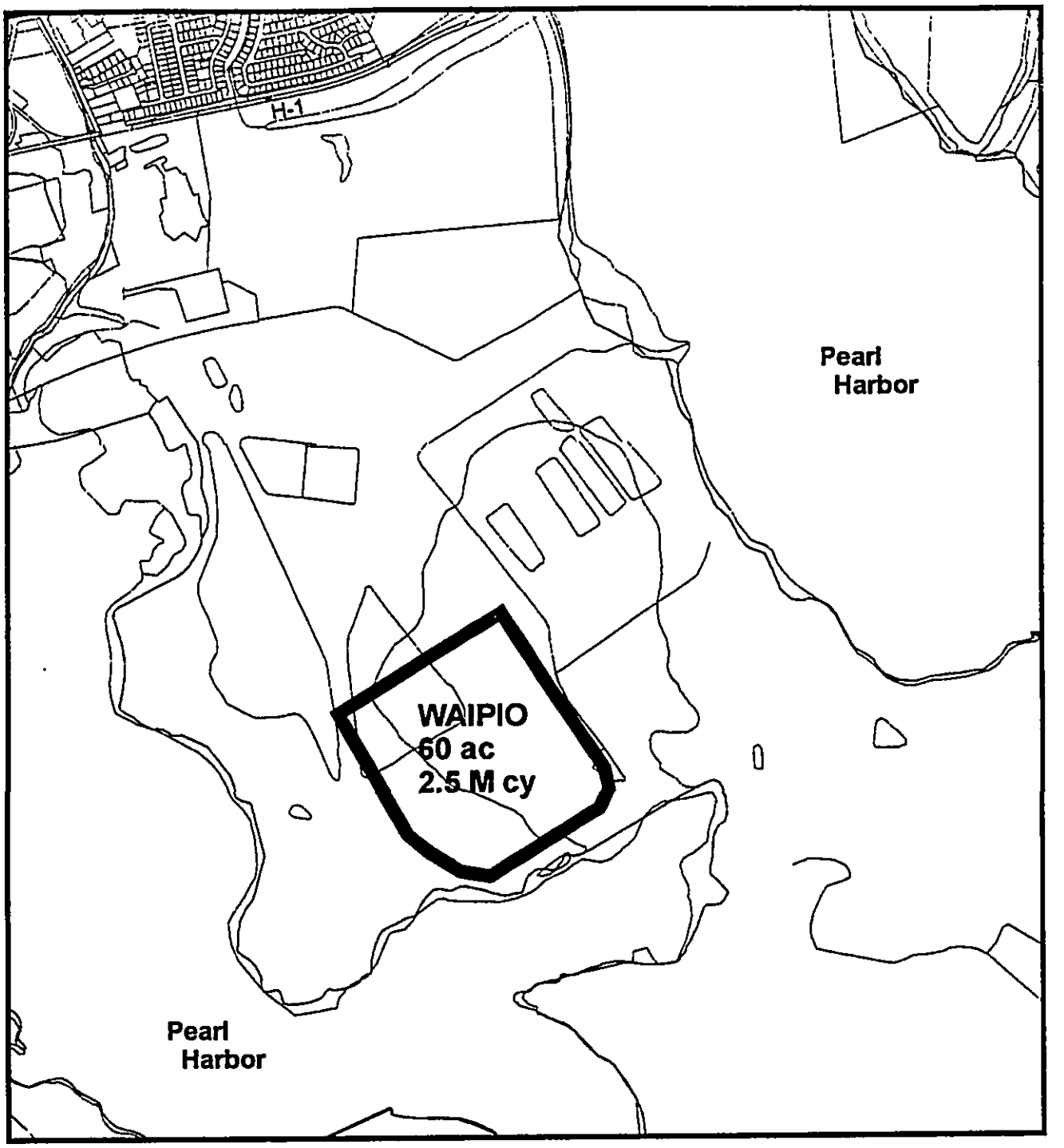
* Source: C & C Honolulu, ENV 2001
IDS Maps 1998, C & C Honolulu

42. WAIPIO - The entire lower Waipio Peninsula is a U.S. Naval Reservation. The site was once leased to Oahu Sugar Company for cultivation of sugarcane. (**Figure 4-39**).

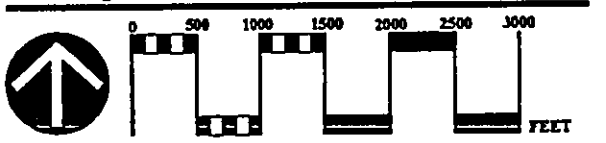
TMK:	4-2-15:por 1 & 6
Acreage:	±160
Ownership:	Federal Government (U.S. Military Reservation). Use of the site for military purposes would increase difficulty of site acquisition.
Adjoining Land Uses:	The site is contained within the Waipio Peninsula between the Middle and West Lochs of Pearl Harbor. North of the site is the town of Waipahu.
Cover Material:	Must be imported
Soils Classification:	Fill land Waste land
City and County of Honolulu Zoning:	F-1
State Land Use District:	Agricultural
Capacity:2.5 million cubic yards	
Lifespan:	±4.2 years (based on 0.6 million cubic yards per year required)



LEGEND

▬▬▬	Site Boundary
OUTSIDE	Underground Infiltration Control (UIC) Line
OUTSIDE	Groundwater Protection Zone (GPZ) Line

FIGURE 4-39
Waipio



Alternatives Analysis for Disposal of Municipal Solid Waste (MSW)
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* Source: C & C Honolulu, ENV 2001
IDS Maps 1998, C & C Honolulu

SECTION 5
ANALYSIS OF ALTERNATIVE OAHU LOCATIONS FOR SANITARY LANDFILLS

5.1 INTRODUCTION

This section provides analysis of data provided in Section 4 and contains the following subsections:

- 5.2 Analysis of Potential Sanitary Landfill Sites on Oahu
- 5.3 Recommendation for the Siting of a Sanitary Landfill Site

5.2 ANALYSIS OF POTENTIAL LANDFILL SITES

The analysis of alternative landfill sites was undertaken through a review of the three (3) primary evaluation criteria. A summary of the evaluation results are provided below.

The analysis of alternative landfill sites are presented in two parts as follows:

Phase I — The first phase of evaluation is designed to segregate sites with potential for development according to ability to meet selected stringent physical siting requirements. These requirements include: Criteria No. 1) location restriction criteria promulgated in 40 CFR Part 258; Criteria No. 2) the capacity requirement that a landfill provide for a disposal period of not less than 15 years; and, Criteria No. 3A) a review of technical and resource criteria, sub-criteria no. 1 - Protection of Natural Resources, which includes ground and surface water, and air quality.

Criteria reviewed under Phase I were subject to a pass/fail evaluation. Inability to meet any of the selected criteria by itself would result in removal of the site from further evaluation. Remaining sites that could fulfill all three requirements were thereafter subject to Phase II of the evaluation.

Phase II

The second phase of evaluation included an analysis of remaining technical and resource criteria which is identified as Criteria No. 3B. This contains sub-criteria numbers 2 through 7, identified in section 4.2, of this report. Each of the remaining sub-criteria were evaluated comparatively with each of the remaining sites to obtain a relative ranking. The sub-criteria reviewed included the following:

Criteria No. 3B List:

1. Compatibility with area land use (sub-criteria no. 2)
2. Protection of natural habitat (sub-criteria no. 3)
3. Protection of cultural resources (sub-criteria no. 4)
4. Technical viability (sub-criteria no. 5)
5. Economic development costs (sub-criteria no. 6)
6. Land acquisition (sub-criteria no. 7)

A relative ranking of remaining Phase II sites are provided in this evaluation. A summary follows at the end of this section.

5.2.1 PHASE I - EVALUATION OF LOCATION RESTRICTION CRITERIA

A review of sites in relation to location restrictions of 40 CFR Part 258 indicate there are three location restrictions that apply to alternative landfill sites identified in this study. These include: 1) Airport Restriction; 2) Floodplains; and, 3) Wetlands. Sites associated with these restrictions include (Table 5-1):

TABLE 5-1
CRITERIA NO. 1
EVALUATION OF LOCATION RESTRICTIONS

40 CFR 258 Siting Restrictions

NO.	SITE	1. Airport Restriction	2. Flood-plains	3. Wetlands	4. Fault Areas	5. Seismic Impact Zone	6. Unstable Areas	Requirement Met?
1	Auloa							YES
2	Barbers Point	X						NO
3	Bellows							YES
4	Diamond Head Crater			X				NO
5	Ewa No. 1	-	-	-	-	-	-	-
6	Ewa No. 2	-	-	-	-	-	-	-
7	Halawa A							YES
8	Halawa B							YES
9	Heeia Kai	-	-	-	-	-	-	-
10	Heeia Uka							YES
11	Honouliuli							YES
12	Kaaawa							YES
13	Kaena	X						NO
14	Kahaluu							YES
15	Kahe							YES
16	Kalaheo							YES
17	Kaloi							YES
18	Kapaa No. 1							YES
19	Kapaa No. 2 & 3							YES
20	Kaukonahua							YES
21	Keekee	X						NO
22	Koko Crater							YES
23	Kunia A							YES
24	Kunia B							YES
25	Maili							YES
26	Makaiwa							YES
27	Makua							YES
28	Mililani							YES
29	Nanakuli							YES
30	Ohikilolo							YES
31	Olomana	-	-	-	-	-	-	-
32	Poamoho							YES
33	Punaluu							YES
34	Sand Island	X	X					NO
35	Waiahole							YES
36	Waianae Expansion							YES
37	Waihee							YES
38	Waikane							YES
39	Waimanalo Gulch Exp.							YES
40	Waimanalo North							YES
41	Waimanalo South							YES
42	Waipio							YES

Description of Location Restrictions

40 CFR Part 258

NO.	SITE	RESTRICTION
2	Barbers Point	1. Airport Restriction - This is due to the proximity of the site less than 10,000 feet of the end of the runways of the former Barbers Point Naval Air Station. These runways are slated for future use as part of a general aviation reliever airport. Distance from the landfill site to the runways is approximately 1.0 miles.
4	Diamond Head	3. Wetlands - the floor of Diamond Head crater is a designated wetland. Historical information indicates the floor of Diamond Head crater was once submerged and later developed into a wetland site with associated characteristics including hydric soils, and wetland associated plant species and avifauna.
13 21	Kaena Keekee	1. Airport Restriction - Both of these sites are subject to location in proximity to the Dillingham airfield located east of the roughly adjoining landfill sites. Kaena is less than approximately 1,500 from the end of the Dillingham airfield runway and Keekee is approximately 2,500 feet from the runway end.
34	Sand Island	1. Airport Restriction - Distance from runways of Honolulu International Airport to the site is less than 10,000 feet. 2. Floodplain - The site is within the tsunami inundation zone and within an area inundated by the 100-year flood zone.

Because of location siting restrictions the above identified sites were removed from further consideration.

5.2.2 PHASE I - EVALUATION OF CAPACITY REQUIREMENT CRITERIA

Criteria No. 2 is based on selection of alternative sites with sufficient space for anticipated long term needs of the City and County of Honolulu. This requirement involves provision for sufficient disposal of refuse for a period of not less than 15 years. Sites which are restricted in providing sufficient capacity are identified in **Table 5-2.**

Sites identified in **Table 5-2,** which did not meet the minimum landfill capacity requirement was removed from further evaluation.

5.2.3 PHASE I - EVALUATION OF TECHNICAL AND RESOURCE CRITERIA NO. 1, PROTECTION OF NATURAL RESOURCES

Technical and resource criteria involves seven (7) factors subject to evaluation:

1. Protection of natural resources
2. Compatibility with area land use
3. Protection of natural habitat
4. Protection of cultural resources
5. Technical viability
6. Economic development costs
7. Land acquisition

This portion of the Phase I evaluation involves review of the first factor, Criteria No. 3A, protection of natural resources. Criteria No. 3B, will evaluate the remaining factors, numbers 2 through 7, which are addressed in the Phase II discussion which follows.

Protection of natural resources, involves evaluation of each of the alternative sites in relation to critical groundwater protection zones, designated as the State DOH, UIC Zone, and the Honolulu BWS Groundwater Zone. Landfills in either of these locations are severely restricted from development. Sites identified in this analysis which are within these zones include the following (refer to **Figure 4-3**):

TABLE 5-2
CRITERIA NO. 2
EVALUATION OF CAPACITY REQUIREMENT

NO.	SITE	C&C Honolulu Capacity Requirement		
		Total Site Acreage	Cap. in Million Cubic Yds.	Requirement Met?
1	Auloa	55.00	2.79	NO
2	Barbers Point	15.00	0.74	NO
3	Bellows	173.00	7.51	NO
4	Diamond Head Crater	115.00	4.30	NO
5	Ewa No. 1	-	-	-
6	Ewa No. 2	-	-	-
7	Halawa A	40.00	1.50	NO
8	Halawa B	60.00	2.20	NO
9	Heeia Kai	-	-	-
10	Heeia Uka	163.00	2.40	NO
11	Honouliuli	22.00	1.65	NO
12	Kaaawa	150.00	5.60	NO
13	Kaena	40.00	1.50	NO
14	Kahaluu	70.00	2.60	NO
15	Kahe	200.00	7.40	NO
16	Kalaheo	-	-	-
17	Kaloi	400.00	24.30	YES
18	Kapaa No. 1	60.00	3.03	NO
19	Kapaa No. 2 & 3	-	-	-
20	Kaukonahua	34.00	1.30	NO
21	Keekee	40.00	1.20	NO
22	Koko Crater	140.00	5.50	NO
23	Kunia A	150.00	5.60	NO
24	Kunia B	190.00	7.00	NO
25	Maili	200.00	9.20	YES
26	Makaiwa	338.00	15.00	YES
27	Makua	600.00	7.40	NO
28	Mililani	34.00	2.20	NO
29	Nanakuli	611.00	13.40	YES
30	Ohikilolo	706.00	15.60	YES
31	Olomana	-	-	-
32	Poamoho	5.00	0.70	NO
33	Punaluu	200.00	7.40	NO
34	Sand Island	150.00	5.60	NO
35	Waiahole	60.00	2.30	NO
36	Waianae Expansion	140.00	6.80	NO
37	Waihee	61.00	2.30	NO
38	Waikane	200.00	7.40	NO
39	Waimanalo Gulch Exp.	60.5*	9.00	YES
40	Waimanalo North	171.00	9.57	YES
41	Waimanalo South	355.00	13.99	YES
42	Waipio	160.00	2.50	NO

* Expansion area only.

Criteria No. 3A
Sites Within Critical Groundwater Protection Zones
BWS Groundwater Protection Zone and UIC Zone

NO. SITES			
7	Halawa A	24	Kunia B
8	Halawa B	27	Makua
10	Heeia Uka	28	Mililani
11	Honouliuli	29	Nanakuli
12	Kaaawa	30	Ohikilolo
13	Kaena	32	Poamoho
14	Kahaluu	33	Punaluu
15	Kahe	35	Waihole
16	Kalaheo	36	Waianae Expansion
20	Kaukonahua	37	Waihee
21	Keekee	38	Waikane
23	Kunia A	42	Waipio

The above identified sites do not meet the requirement for siting a landfill outside of the respective groundwater protection zone and therefore, were removed from further consideration.

A summary of alternative sites evaluated by the site selection criteria is provided in **Table 5-3.** Sites remaining from the Phase I evaluation involve the following which were selected for further evaluation in Phase II of this analysis:

1. Site No. 25 - Maili
2. Site No. 26 - Makaiwa
3. Site No. 39 - Waimanalo Gulch Expansion
4. Site No. 40 - Waimanalo North*

* Note: Further evaluation by ENV indicates the State Department of Land and Natural Resources, Division of Forestry and Wildlife, is currently working to designate this site as a Forest Reserve. Although not now designated, pending action by the Board of Land and Natural Resources will effectively remove this site from further consideration by the City and County of Honolulu.

TABLE 5-3
SUMMARY OF PHASE I EVALUATION
ALTERNATIVE LANDFILL SITE INVESTIGATION

NO.	SITE	CRITERIA #1 40 CFR 258 Location Restrictions	CRITERIA #2 C&C Honolulu Capacity Requirement	CRITERIA #3A Protection of Natural Resources-Groundwater	SITES ELIMINATED FROM CONSIDERATION
1	Auloa		X		X
2	Barbers Point	X	X		X
3	Bellows		X		X
4	Diamond Head Crater	X	X		X
5	Ewa No. 1	-	-	-	X
6	Ewa No. 2	-	-	-	X
7	Halawa A		X	X	X
8	Halawa B		X	X	X
9	Heeia Kai	-	-	-	X
10	Heeia Uka		X	X	X
11	Honouliuli		X	X	X
12	Kaaawa		X	X	X
13	Kaena	X	X	X	X
14	Kahaluu		X	X	X
15	Kahe		X	X	X
16	Kalaheo		X	X	X
17	Kaloi			X	X
18	Kapaa No. 1		X		X
19	Kapaa No. 2 & 3		X		X
20	Kaukonahua		X	X	X
21	Keekee	X	X	X	X
22	Koko Crater		X		X
23	Kunia A		X	X	X
24	Kunia B		X	X	X
25	Maili				
26	Makaiwa				
27	Makua		X	X	X
28	Mililani		X	X	X
29	Nanakuli			X	X
30	Ohikilolo			X	X
31	Olomana	-	-	-	X
32	Poamoho		X	X	X
33	Punaluu		X	X	X
34	Sand Island	X	X		X
35	Waiahole		X	X	X
36	Waianae Expansion		X	X	X
37	Waihee			X	X
38	Waikane		X	X	X
39	Waimanalo Gulch Exp.				
40	Waimanalo North	-	-	-	X
41	Waimanalo South			X	X
42	Waipio		X	X	X

5.2.4 PHASE II - EVALUATION OF TECHNICAL AND RESOURCE SUB-CRITERIA NOS. 2 THROUGH 7

A scale to denote ranking was developed for the Phase II portion of the evaluation to review remaining technical and resource criteria numbers 2 through 7, in relation to each of the remaining alternative sites. A ranking system of 0 to 10 points was assigned to each factor as follows:

1. Compatibility with area land use - As noted in Section 4.2.3.2, the existing land use situation on Oahu provides no ideal conditions where the siting of a landfill would prove fully compatible with surrounding land uses. For this reason all sites are assigned a score of zero (0).

2. Protection of natural habitat - Natural habitat conditions are discussed only briefly in this study since an assessment of flora and faunal conditions would require further analysis of site specific conditions at each of the alternative sites. For purposes of this study all sites are assigned a score of zero (0), with the notation that further study should be conducted as required, in the event that any of the alternative sites prove viable based on screening of remaining criteria.

3. Protection of cultural resources* - Cultural resources include potential presence of archaeological or cultural remains at the landfill site. Although site specific archaeological analyses of each of the alternative locations was not conducted as part of this study, limited data from previous studies are available. The limited nature of the data suggests that should any of the alternative sites be considered for future development that a site specific archaeological reconnaissance be completed, as required, to investigate further potential for negative effects to historic resources. Ranking of this criteria will be as follows:

Score	Description
0	The site is located in an area with known "significant" archaeological resources.
5	The site is not expected to have significant historical resources. However, an archaeological reconnaissance or inventory survey will be required prior to site development.
10	The site is known to be clear of archaeological and historic resources (based on prior documented archaeological studies or reports).

* Note: The Waimanalo Gulch Expansion site has been subject to archaeological review in the report, "An Archaeological Inventory Survey for the Waimanalo Gulch Sanitary Landfill Project Site, Honouliuli, Ewa, Oahu," by Cultural Surveys Hawaii, August 1999. According to the report no adverse impact to archaeological and cultural resources within the proposed landfill expansion site is anticipated.

4. Technical viability - This criteria involves issues related to development of the site based on consideration of engineering feasibility which includes:

- Whether cover material is available on-site or if it must be imported; and,
- Need for development of engineering alternatives relating to construction of site access roads, and proximity of utilities including water, electricity, sewer, and telephone service.

Score	Description
0	No adequate soils are available. The site requires hard rock excavation, and requires more than 1 mile of new access roads and is more than 1 mile from existing utilities.
5	Some on-site soils are available for daily cover, but there are no clay soils for use as liner. The site is less than one half mile from existing roads and utilities.
10	The site has adequate soils for use as daily cover and clay liner. There is potential to achieve a soils balance with excavated materials used for landfill cover and clay liner. Utilities are close to major roads and utilities.

5. Economic development costs - This criteria involves consideration of site development, access and haul distance costs, and materials costs, as follows:

Site Development Costs include costs related to constructing new facilities (weigh station, administration building, maintenance/equipment storage facility); construction of new roads for operations within the site; costs for improvements to existing internal roads; infrastructure costs for telephone, water, sewer and electricity; and other improvements necessary for operation of the landfill.

Access and Haul Distance costs include construction of access roads from the main road or highway onto the landfill operations site; road improvement costs to provide connection to existing roads/highway; and, the cost to haul solid waste from transfer stations to the landfill as well as hauling of ash generated from H-POWER to the landfill.

Material costs primarily involve the cost of procurement and importation of cover materials to the landfill.

Score	Description
0	Anticipated development costs are high in relation to all sites considered
5	Anticipated development costs are moderate compared to all sites considered
10	Anticipated development costs are lowest of all alternative sites considered

6. Land acquisition - This criteria relates to whether the site is publicly or privately owned. Public lands are preferred because of ability to use existing rights of way and lower costs associated with development. Private land is less desirable due to need for acquisition or condemnation, as required. Under some circumstances the set aside of public lands may preempt use of a site for development. This situation therefore, could effectively remove the site from development.

Score	Description
0	The site is privately owned or used by the U.S. Military
5	The site is publicly owned and is encumbered by existing recreational or related uses.
10	The site is owned by the City and County of Honolulu and available for landfill uses.

A summary screening of Phase II - technical and resource criteria is provided in **Table 5-4:**

TABLE 5-4
EVALUATION OF REMAINING TECHNICAL AND RESOURCE CRITERIA
ALTERNATIVE LANDFILL SITE INVESTIGATION

		Remaining Evaluation Factors						
NO.	SITE	1. Compat. w/Area Land Use	2. Protection of Natural Habitat	3. Protection of Cultural Resources	4. Technical Viability	5. Economic Development Costs	6. Land Acquisition Issues	RANKED SCORE
25	Maili	0	0	5	5	5	0	15
26	Makaiwa	0	0	5	10	5	0	20
39	Waimanalo Gulch Expansion	0	0	10	10	10	10	40
40	Waimanalo North*	N/A	N/A	N/A	N/A	N/A	N/A	N/A

*Site no longer considered viable for evaluation.

5.3 RECOMMENDATION FOR THE SITING OF A SANITARY LANDFILL SITE

The results of the final evaluation criteria in **Table 5-4** indicates the following ranking of sites:

5.3.1 SITE RECOMMENDATION NO. 1 - WAIMANALO GULCH EXPANSION

Waimanalo Gulch Expansion is the highest ranked site with an evaluation score of 40, based on evaluation of remaining technical and resource criteria. Positive site characteristics include the following:

- The proposed expansion site is located within an existing sanitary landfill site.
- The site has already been subject to extensive environmental and archaeological review. Flora, fauna, and archaeological reviews have indicated no adverse potential for negative environmental impacts.
- Technical and economic development costs are relatively low based on existing, usable soils that can be reclaimed for cover material. Proximity of the site to access roads and H-POWER is also good.

- Land acquisition considerations are positive in that the land is already under ownership of the City and County of Honolulu.

Negative site characteristics include:

- While the proposed expansion site is within the property boundary of an existing landfill, the region is facing increasing urbanization pressure in the form of residential, resort, commercial, and business development. Industrial uses are also prevalent within the region and include Campbell Industrial Park, Barbers Point Harbor, and the former Barbers Point Naval Air Station (slated for redesignation as the Kalaeloa Community Development District) which will include a general reliever airport and other public/community uses. Residents in the surrounding communities of Ko Olina, Honokai Hale, Makakilo, Kapolei, Waianae, and Ewa have expressed opposition to any further expansion of the existing landfill site. Development of the site will therefore require a high level of effort and coordination with the area community to address stated concerns involving odor, windblown and refuse truck associated litter, and other potential complaints.

5.3.2 SITE RECOMMENDATION NO. 2 - MAKAIWA

Makaiwa is the second recommended site with an evaluation score of 20. Positive site characteristics include the following:

- The site is technically viable for development based on soil materials available for use as cover. Anticipated engineering difficulty is expected to be relatively low based on site conditions and level of development required for access roads and utilities.

Negative site characteristics include:

- Existing concern by the community over the perceived exclusive use of the region for landfills. The relative proximity of the site to the existing Waimanalo Gulch Sanitary Landfill would be considered by some community members as unacceptable.
- Land acquisition costs are anticipated to be high due to designation of the site by the Estate of James Campbell for future residential development.
- Design, engineering and construction costs are also expected to be somewhat higher due to site conditions requiring infrastructure improvements. New access and internal roadways, buildings, and utilities would need to be developed.
- Further environmental evaluation of flora, fauna, and archaeological resources will be required. In addition, should subsequent environmental investigation involve new discoveries of federal or state listed threatened and endangered species, or significant archaeological and cultural resources, the site could become discounted from further consideration.

5.3.3 SITE RECOMMENDATION NO. 3 - MAILI

Maili is the third recommended site with an evaluation score of 15. Positive site characteristics include the following:

- The site is technically viable for development based on soil materials available for use as cover. Anticipated engineering difficulty is expected to be moderate based on site conditions and level of development required for access roads and utilities.

Negative site characteristics include:

- The site is privately owned and may not be available for sale. However, this may change based on selection of a usable boundary that could involve public land ownership.
- Location of the site is further distant from HPOWER and refuse transfer stations which would involve higher refuse transportation costs.
- Access to the site is limited due to the location of Farrington Highway within the Maili - Waianae corridor.
- Further environmental evaluation of flora, fauna, and archaeological resources will be required for areas within the site that are not now under active use for limestone quarrying.

5.3.4 CONCLUSION

Although the Waimanalo Gulch Expansion is the recommended alternative for development of a sanitary landfill site, a review of prior studies indicates that ongoing urbanization of Oahu has continued to reduce and place increasing pressure on remaining locations for use as sanitary landfills. This has already occurred at a number of locations including Ewa No. 1 and 2, Heeia Kai, and Olomana, where residential and homestead development has occurred directly on a former site previously identified for potential landfill development. It is expected with future development that this situation will only continue to further reduce potential locations already identified in this evaluation.

This requires the need to select and maximize use of landfill resources wherever they are located. This is due to several factors, which are exacerbated by an existing scarcity of land:

- Landfills represent a major public infrastructure investment. High public costs require that any investment into a particular location be optimized to maximize the public benefit which would accrue to all the residents of Oahu;

- Encumbrance of a site for an extended period of time requires that the site be responsibly managed and maintained. This is because of potential for future public use of the land for purposes including park, recreational, or other uses (such as Kakaako Beach Park); and,
- Finally, the contentious nature of selecting, siting and operating a landfill is not an easy undertaking. Any site selection must be done with care and consideration for the affected community. As identified in Section 4.2.3.2, appropriate coordination must be made with the community to effectively minimize and mitigate the potential for adverse impacts. Because this level of effort is high, the proposed site must be maximized with regard to storage capacity and the ability of the City and County of Honolulu to assist with an islandwide reduction of waste streams over time.

At the same time, parallel efforts to improve landfill utilization should involve use of new waste reduction technologies as they demonstrate technical and economic feasibility at a scale required for Oahu. Premature adoption of waste reduction technologies in the face of public opposition to landfill siting could result in unacceptable and unanticipated impacts, including:

1. Major loss of taxpayer dollars through investment into a proven technology that has not been applied at a production level scale - Any adoption of new technology must be based on the demonstrated application of the technology at the scope and scale required. Conversely, there must be sufficient assurance that the existing and future waste streams of the island of Oahu are capable of being handled by the proposed process;

2. Risk to both the environment and human health and safety based on unknown operating outputs of the proposed technology - It is also possible that in the course of environmental permitting that if sufficient environmental information on operating parameters are not available, that there will be a failure to obtain certain required permits; and,

3. Loss or unavailability of sufficient MSW landfill capacity in the event of extended downtime, breakdowns, or lengthy maintenance required due to use of a novel technology.

Finally, while Waimanalo Gulch Expansion is the recommended location for the current landfill requirement, it is reiterated that future land use changes at Makaiwa and Maili could have the potential to further reduce these locations for development.